JPRS-UEQ-87-007

4 MAY 1987

ENGINEERING AND EQUIPMENT

USSR Report

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JPRS-UEQ-87-007

4 MAY 1987

USSR REPORT

ENGINEERING AND EQUIPMENT

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AERONAUTICAL AND SPACE

UDC 629.735.33.015.4

ENSURING THE SERVICE LIFE OF DESIGNS (EXPERIENCE IN AIRCRAFT CONSTRUCTION)

Moscow MASHINOVEDENIYE in Russian No 5, Sep-Oct 86 (manuscript received 27 Jan 86) pp 11-18

[Article by A. F. Selikhov, Zhukovskiy]

[Text] The high cost of an aircraft makes it necessary to operate it for 20-25 years with ever increasing intensity (2,000-4,000 flight hours annually). Therefore, the required service life of its design increases continuously. The required and achieved service lives comprised 20,000-25,000 flight hours in 1960-1970. The service life of aircraft that are operated for a long period is now 30,000-40,000 flight hours (15,000-30,000 flights), while the service life of those being designed is calculated at 45,000-60,000 flight hours. As foreign experience indicates, the required service life of a design may reach 80,000-90,000 flight hours in the future.

Increased requirements on weight improvement, a significant level of variable loads, long service life and large number of functional and loading cycles results in the fact that the service life of the main load-bearing structure of an aircraft is limited, i.e., the design may exhaust its load-carrying capacity prematurely. The main factors that limit the service life are fatigue of the main load-bearing structure, corrosion damage and wear of movable elements.

The most frequently encountered and most hazardous due to unexpected causes of possible cessation of operation (limitation of service life) is structural fatigue due to exhaustion of its load-carrying capacity and initial production defects and also damage caused by corrosion and wear. The wide dispersion of fatigue strength leads to the need to consider the problem of flying life as one of providing reliability and primarily of structural safety. The main criteria of this problem with respect to passenger aircraft are as follows.

1. Breakdown of the structure, damaged by cracks due to fatigue of the main elements under the influence of repeated loads during regular operation, including the flight "functioning cycle," loads during flight in rough air and during motion over uneven airfields and also rare extreme values of these loads should essentially be improbable. The "normalized" probability of this event is $P_H = 10^{-9}$ to 10^{-10} 1/flight hour [1].

2. Damage to individual structural elements, the probability of which $P_{п} > P_{н}$, should be discovered in time by inspections according to special regulations using the necessary flaw-detection devices. The detection reliability should provide the required structural safety.

3. The probability of damage $P_{п}$ to load-bearing elements should meet the requirements of aircraft readiness for takeoff (the probability of completion of flights is $P_{г} = 0.97-0.99$). This requirement limits the intensity of structural "failures" to a value of $\lambda_{п} = 0.0002-0.0005$ 1/flight hours.

4. The checkability and repairability of the structure, the frequency and technology of inspections should meet the requirements of operational technological effectiveness, determined by labor expenditures on maintenance and repair during operation. Expenditures for maintenance of passenger aircraft being designed should not exceed 8-12 normative hours/flight hours for the aircraft as a whole.

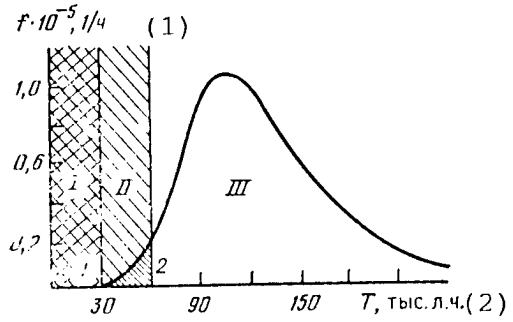

Figure 1. Probability Density of Damage to Structure f and Permissible Flight Hours T With Different Confidence Levels: 1--safe service life; 2--service life of fleet with safe levels of damage

KEY:

1. 1/hr
2. thousand flight hours

The enumerated criteria are limitations in providing the required service life of the design with minimum expenditures of mass. This problem can be solved only through a number of measures implemented from the very beginning of design. The first of them is selection of "design" conditions for ensuring service life, which, besides the combination of operating conditions, should contain methods of providing structural safety. Both the required longevity margins and their required measures on timely detection of damage and requirments on the strength of a damaged structure are dependent on them.

The main feature of the problem of supporting the service life of structures, which results in a need to solve this problem as one of reliability, is the significant dispersion of the mean time between failures of the design before damage appears [2]. This dispersion is determined by the stochastic nature of operating conditions, by the load of the aircraft during flight under

atmospheric turbulence and when moving along uneven airfields and also by the dispersion of the characteristics of fatigue strength [3, 4]. The developed probabilistic model of the longevity of a design in operation and the theory of providing safety of the design, based on it, made it possible to determine the main principles of ensuring the service life and of normalizing the required longevity margins, requirements on the design and monitoring procedures during operation.

The typical distribution of longevity (service life) of a design before the first damage in operation is shown in Figure 1. The entire range of variation of longevity can be divided into three zones as a function of the method of ensuring the service life [5].

Zone I, in which safety is guaranteed by low probability (by the practical improbability) of damage to the design, the so-called zone of safe (designated) service life.

Zone II, in which the resulting damage should be detected on time during special inspections. The design should have operational viability in this case, i.e., either a slow rate of development of a crack (permissible damage) or reserve elements (safe damage).

Zone III, operation in which may be permissible only if the damage does not result in a decrease of the level of safety of the structure.

The most advantageous and practically achievable for aviation design is the method of ensuring operational survivability (safe or permissible damage), which permits a significant increase (twofold) of the flying life of the design at moderate operating expenses.

The beginning of inspections $T_{н.о}$ and the interval between inspections ΔT is determined in Figure 2 as a function of the rate of increase of the crack and also of the intensity of reducing the residual strength of the design. Damage safety is provided by limiters of development of a crack or standby elements, which permit the designs to tolerate the maximum operating load at calculated damage. Calculated damage in the wing and fuselage are shown in Figure 3 (1--wing; 2--fuselage; 3--limiters (stringers), 4--tape limiters).

A number of measures must be implemented during the very beginning of design, during manufacture of the aircraft and during operation of it to ensure the required service life and reliability of the structure [6, 7]. The combination of these measures is the organizational-engineering system, the structure and main problems of which are presented in Figure 4.

The characteristic features of the system are: formulation of conditions for ensuring service life and reliability before the beginning of design, taking the requirements of service life and reliability of the structure into account, beginning with the earliest phases of design, continuous scientific and technical support, implemented throughout the entire life cycle of the aircraft (fleet of aircraft) from the phase of the technical proposition and until the last models are copied, unity of models and methods of analysis and

forecasting the service life characteristics of the structure during phases of the life cycle, presence of permanent feedback that ensures the necessary correction of the models and methods from the results of laboratory and flight tests and especially mass operation of the fleets of aircraft structures.

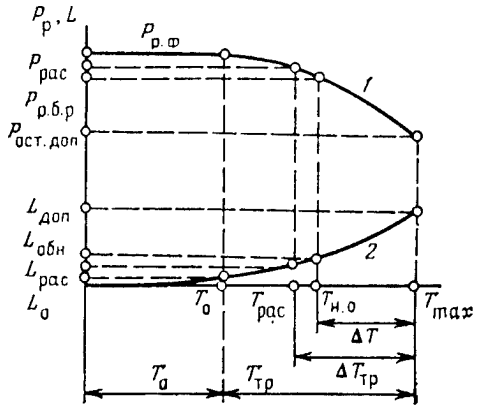

Figure 2. Determined Diagram of Ensuring Survivability Using Principle of Permissible Damage (Slow Growth of Cracks): 1--residual strength; 2--growth of cracks; loads: P_p--breaking; $P_{рас}$--calculated; $P_{р.б.р}$--breaking during safe flying life; $P_{ост.доп}$--minimum permissible. Length of crack: $L_{доп}$--maximum permissible; $L_{обн}$--minimum detectable; $L_{рас}$--corresponding to $P_{рас}$; L_0--initial length of crack at which $P < P_p$. Flying life: T_0--before appearance of crack; T_{max}--maximum permissible; $T_{тр}$--period of growth of crack; $T_{рас}$--mean cycles between failure at which design tolerates $P_{рас}$; $\Delta T_{тр}$--mean cycles between failure at which load-carrying capacity varies from $P_{р.б.р}$ to $P_{ост.доп}$

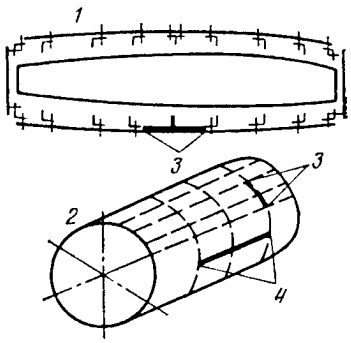

Figure 3

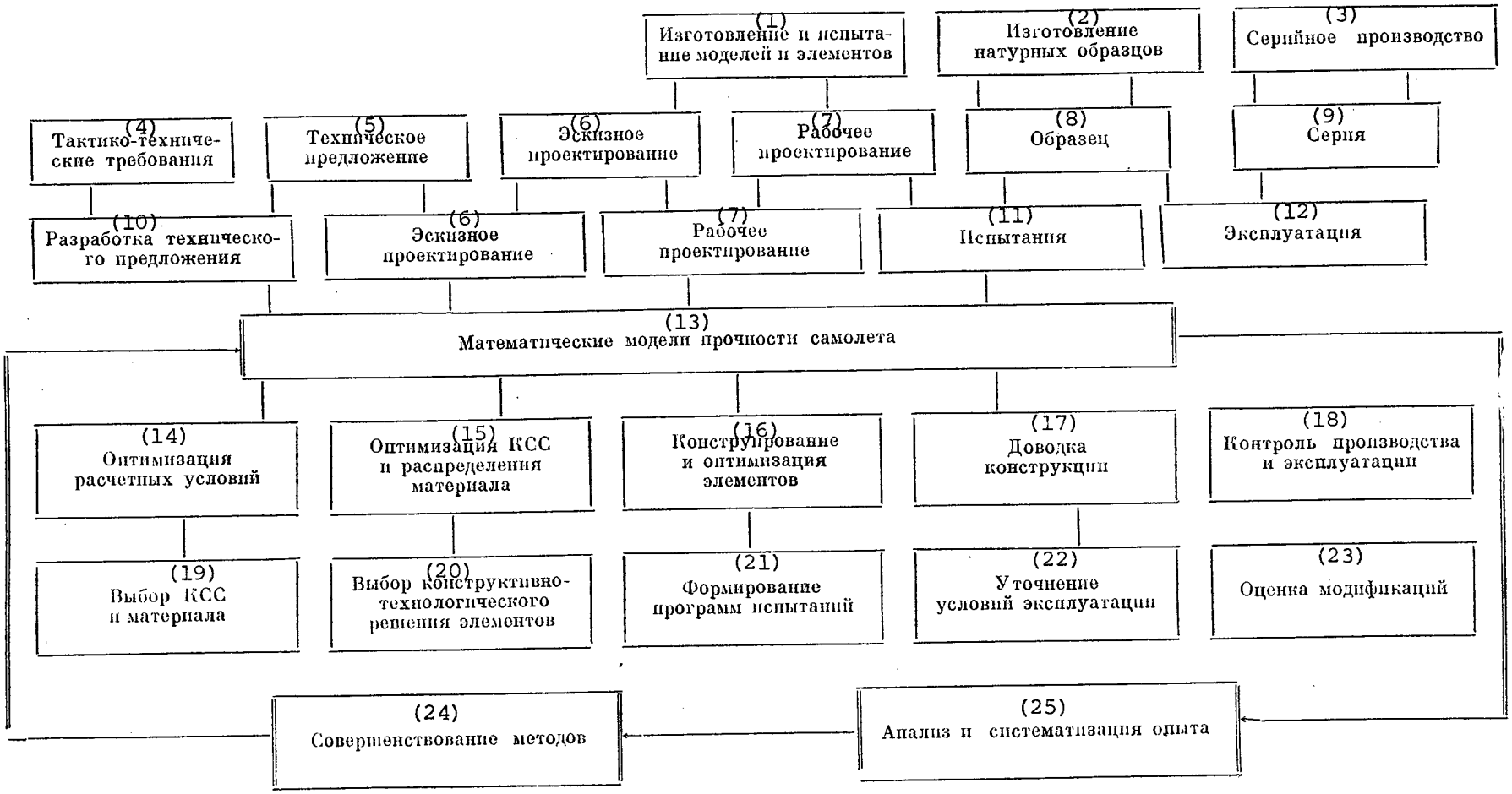

Figure 4

(Key on following page)

KEY:

1. Manufacture and testing of models and elements
2. Manufacture of full-scale models
3. Serial manufacture
4. Tactical-engineering requirements
5. Technical proposal
6. Preliminary design
7. Contract design
8. Model
9. Series
10. Working out technical proposal
11. Tests
12. Operation
13. Mathematical models of aircraft strength
14. Optimization of calculated conditions
15. Optimization of structural-power circuit and distribution of material
16. Design and optimization of elements
17. Modification of design
18. Monitoring of production and operation
19. Selection of design-power circuit and of material
20. Selection of design production solution of elements
21. Formulation of test programs
22. Refinement of operating conditions
23. Estimation of modifications
24. Improvement of methods
25. Analysis and classification of experience

One of the most important is the design model used in practice. This model includes the airframe-power circuit (KSS) of the aircraft, which is an object of optimization and serves as the basis for determining the total stress-strain state. It includes standardization of structural zones that take into account methods of calculated-experimental completion of their service life characteristics and also the "contribution" to the total mass of the design and, accordingly, the order, volumes and content of work and design-production measures (see table) to ensure longevity and operational survivability.

Special attention is devoted to so-called regular zones, containing longitudinal joints of the skin with the strengthening longitudinal framing in thin-walled structures of the airframe. The level of permissible nominal stresses and to a decisive extent the weight of the design are determined with regard to the length and homogeneous nature of stress concentrators (bolt and rivet connections, spot welding) and, accordingly, with regard to the ineffectiveness of local forces of the fatigue strength characteristic and to breakdown of regular zones. The main features that provide required flying life and reliability of regular zones are selection of the materials with the corresponding longevity characteristics, breaking strength and resistance to growth of fatigue cracks, the use of long-lived fasteners (joints with guaranteed tension) and also special use of elements of the strengthening framing as limiters of crack propagation. A very significant additional means of increasing the weight effectiveness of the regular zones of the wing is the use of active load-control systems, which reduce the level of variable stresses in the structure.

PRELIMINARY DESIGN		CONTRACT DESIGN
Regular zone ("spar-skin" joints, "stringer-skin" seams)	Power irregularities (zones of landing gear, engine suspension, mechanization zones; "wing-fuselage" joint)	Structural irregularities (cutouts, stringer tips, transverse joints and so on)
Active load control Long panels L > 25 m Optimized alloys Mass resource fastening High-strength stringers Crack propagation limiters	Stress macrocontraction compensation Multicomponent stress accounting Ease of monitoring	Minimization of concentration factors Minimization of local bends (including multicut joints) Use of fasteners with supertightness Strengthening of holes and transitions of thicknesses

The main task of the broad list of design-production measures, directed toward ensuring the longevity of irregular zones (see table) (sections of local significant variation of cross-sections or of nature of force flows), is reducing to a minimum the number of modifications and reinforcements of the structure during operation and during serial manufacture because of premature fatigue damage. Local strengthening of changes of thicknesses is used extensively for this purpose, stress concentration factors are minimized, force transfer eccentricities in zones of transverse joints are eliminated and panel cutouts and other points of possible fatigue damage are eliminated. The capabilities made available to the entire range of design-production measures are implemented and confirmed during support and development of the service life characteristics, conducted in the following basic directions.

1. Determination of the operating conditions and levels of variable loads on the airframe assemblies. The calculated load model includes the spectral characteristics of unevennesses of airfields and zones of atmospheric turbulence and also takes into account the aeroelastic response of the aircraft to these disturbances. Experimental investigations of loads during flight tests yield information for correction of both the perturbation model and of the dynamic response of the aircraft. Processing the flight log data and readings of the onboard recorders (K-3-63, MSRP-64) permits one to check the actual operating conditions and to take into account the individual load of each model of the design. Development of an onboard automatic service life consumption system for the most important structural elements (onboard resource counter--BSR) is now being completed.

2. Calculation of total and local stress-strain state of regular and irregular structural zones. Modern powerful computer complexes, operating on the basis of the finite element method, are used for these purposes. One of these complexes is the multipurpose automated calculating system (MARS), which calculates the stress-strain state of complex designs of arbitrary shape, the eigenfrequencies and modes of oscillations, temperature stresses and also optimization of the structural-force layout for static strength conditions,

service life and aeroelasticity. A high level of automation of the phases of preparation of the calculated data, of making calculations, processing and display of results permits one to determine the stress-strain state with the necessary resolution for a large number of combinations of external effects (calculated cases of stress), including those in operating modes of typical use of an aircraft. The second version of the system has a capacity of ~200,000 Fortran statements, is adapted to most computers used in the sector and has a labor intensity of calculations of not more than 0.2 normative hours/1 unknown. This system is basic for integrated automation of calculation-experimental investigations of strength and introduction in other sectors of industry. The developers of the system support it in operation and further development. More detailed examination of the stress-strain state of specific sections, containing potential foci of fatigue damage, is carried out on the basis of specialized computing complexes to determine the local stresses and strains. One of them is the Fitting complex, which also utilizes the finite element method and takes into account the distribution of forces for the fastening parts in transverse joints, fittings and other complex assemblies.

3. Calculation of longevity, time of development of cracks and residual strength of the structure on the basis of data on variable stresses and strains of elements and assemblies. The existing system of the calculating methods is closely related to the adopted standardization of structural zones and accounts for the multiplicity of stress concentrators in regular zones, the effect of contact forces on fastening elements of the longevity of joints, accounts for elastic-plastic effects during variable loading of assemblies of complex configuration, predicts the time of growth of cracks during transient loading and estimation of strength during damage of structures with reinforcements and also accounts for a number of other important features of external effects that cause fatigue and breakdown of primary structure. The use of linear mechanics methods of breakdown shows the need for further development of them due to the more accurate accounting for the kinetics of elastoplastic deformation at the vertex of the crack and improvement of local criteria of plasticity and failure.

4. Experimental development of design-production decisions in preliminary and contract design phases on basis of tests of specimens of material, structural elements, full-scale panels, assemblies and structural fragments. Soviet and foreign experience shows that a timely experimental check of the adopted decisions, conducted in sufficient volume (~2,000-4,000 specimens, ~100-200 panels and assemblies per type of aircraft), is an extremely effective method of preventing premature failures during full-scale tests and operation, which lead to very large expenditures to correct their consequences. A necessary means for experimental development of structural elements are test machines and benches with electrohydraulic servocontrol and control computer, which permit simulation of load similar to the real operating load. A number of experimental models of this equipment has now been developed in the aviation industry, which can be recommended for serial manufacture. The experience of developing experimental equipment shows that one of the necessary conditions for ensuring its reliability and quality is experimental operation at baseline (head) enterprises and at scientific research organizations.

5. Full-scale laboratory service life tests of the structure as a whole which is a means of a final check of the longevity characteristics and operating

survivability for formulating the conditions of safety and operating reliability within the intended service life of the aircraft. Developed modern test benches for multichannel computer-controlled tracking loading permit simulation of the external variable loads on all main structural assemblies simultaneously (wing, fuselage, tail fins, landing gear, engine pylons and so on), which correspond in value and sequence to all standard operating modes of the aircraft. To conduct full-scale tests, which simulate to a sufficient degree the operating conditions, a number of systems and equipment had to be developed and assimilated [8]: those that simulate the loading and heating conditions, those that simulate and measure the structural state (stress, strain and temperature), those that monitor the structural integrity and those that determine the dynamic characteristics. The greater part of equipment is either manufactured in small series (multichannel load system of Nadezhnost automated production process management system: K-742 mass strain measurement system, ASURI and ARZNI four-channel control system, or is manufactured and tested in the form of experimental models which can be fabricated serially (system for AVDI-1 vibration tests, LIUS-TEST and LIUS-TEMP systems for loading and heating with digital control, set of flaw detection equipment and K-752S and K-752D system for mass static and dynamic strain measurement).

To introduce these and other developments into other sectors of machine building, one must determine the permanent manufacturers of this equipment, produce systems in complete sets with control computer, input-output devices and data display and also with a complete set of systems and applications software, constant maintenance of systems in operation on the basis of organizing service centers and close ties with head institutes of the sectors, which can render methodical assistance in support and development of these systems, is necessary.

Full-scale tests under laboratory conditions should now be considered as an operating model for all basic measures of supporting the service life: monitoring loads, monitoring accumulation of damage, conducting a check of the structural state and repair of damage. Based on the results of full-scale laboratory tests of the aircraft in a volume that exceeds the designated flying life several-fold, the fleet of designs goes into regular operation in the presence of a joint Agreement of the special design office-developer, scientific research institutes of industry and the client, which contains if necessary a list of the phase modifications, replacement of parts and primarily of regulations of inspections that ensure the safety and operating reliability according to conditions of fatigue strength.

6. Continuous monitoring of the actual operating conditions and technical status of the operated fleets of designs with periodic generalization of the results and if necessary correction of an inspection and modification program as an inseparable constituent part of the entire procedure of maintaining the required safety level. Modern complexes for probability-statistical analysis of parameters of the longevity distribution functions, which take into account the actual accrued operating times, the presence or absence of cracks on different models, which ensure sufficiently reliable determination of the mean values and dispersion of longevity and comparison with laboratory prediction for refining the conditions of ensuring the service life and structural reliability.

Phased introduction of the system for ensuring the service life and primary airframes in design, test and operating phases made it possible to implement them into operation approximately five to seven times more than on foreign major aircraft, the safety level according to conditions of fatigue strength and failure and also a significant increase (1.5-2-fold) of the proposed total service lifewhile providing the required efficiency of the designs of new aircraft.

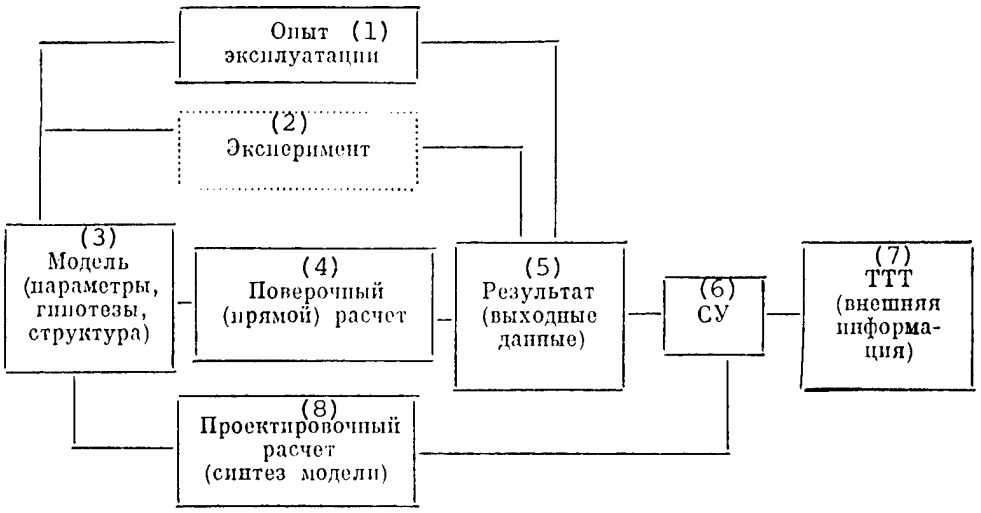

Figure 5. Standard Module for Automated Flying Life and Reliability Support System; SU--comparison of results and control of analysis

KEY:

1. Operating experience
2. Experiment
3. Model (parameters, hypotheses, structure)
4. Check (direct) calculation
5. Result (output data)
6. SU
7. TTT (external data)
8. Design computation (synthesis of model)

The primary task for further development of the system is a significant increase of the performance (an increase of completeness and accuracy and also a reduction of labor intensity) of the calculation-experimental development and checking of the service life characteristics of the design. The main method of solving this problem is integrated automation of the work on the basis of automated maintenance simulation of investigations of the object at all levels and phases of development (Figure 5).

The manufacture of standardized test equipment with control complexes and also effective coordination of developments for further improvement of computer complexes based on the finite element method, models of elastoplastic behavior and failure of elements, extensive investigation of the physics of strength failures and, finally, development of integrated models of service life and reliability of complex designs under intensive operating conditions must be provided for the fastest development and duplication of automated systems for supporting the service life and reliability of machine-building products.

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ADVANCES IN RAILROAD CAR LUBRICATION DISCUSSED

Moscow GUDOK in Russian 11 Oct 86 p 2

[Interview with G. Zaikin, chief, bearing assembly and lubricants division, VNIIZhT, and A. Nesterov, director, lubricants laboratory, by O. Kostromina; no occasion, date or place specified: "What Is 'Buksol'?," "Technical progress is our objective," "In the lubricants laboratory of VNIIZhT"]

[Text] [Question] The lubricants available today, which are supposed to increase the reliability with which slipping parts function are not measuring up to today's requirements. What can the scientists come up with to solve an urgent problem like this?

This is the question I put to G. Zaikin, chief of the bearing assembly and lubricants division of VNIIZhT [All-Union Scientific Research Institute of Railroad Transportation], and A. Nesterov, director of the lubricants laboratory.

[Answer (Zaikin)] Scientists at our institute have been engaged in a major effort in this direction. And I am going to be so bold today as to declare that we are on the brink of achieving our objective. Lubricant greases were first introduced back before the war. By making some changes in LZ-TsNII, which had been developed on the basis of an earlier material, I-13, we were able to achieve more reliable operation of our assemblies over longer periods of time and over a fairly broad range of speeds. It then appeared that at that point we had solved the problem. Our sodium-calcium lubricants were proving themselves to be superior in quality to samples of foreign materials. Under operational conditions, however, these lubricants suffered from a major drawback: they were absorbing moisture. Over a prolonged period of operation the bearings would begin to corrode. Our scientists then proposed a new modification in the form of TsIATIM-203, but to make this material required the use of some ingredients which were always hard to get hold of. Then we saw the appearance of ZhRO. This material, however, did not prove reliable when it was used on railroad cars with cylindrical roller bearings which bear axial loads on the ends of the bearings. The ends of these bearings and the working surfaces of the wheels would be scored when the train was in motion. Fine particles of metal would then work their way into the lubricant, which would degrade its properties to a substantial degree.

[Question] Georgiy Ivanovich, all these things have taken us back into the past. What does the situation look like today? To judge by the letters to the editor, it's pretty clear that the railroad car makers aren't very happy with the YeZhS lubricant.

What I'd like to know here is what the situation looks like to you as an expert in this field.

[Answer] In tests VNIIZhT has conducted on an experimental wheel assembly using the YeZhS lubricant this material yielded some good results. It was seen at that point to be a superior lubricant. So Gosstandart [State Committee on Standards of the USSR Council of Ministers] decided to go ahead and approve it for operational use but at the same time to continue to monitor the performance of the material under operational conditions. Here, unfortunately, it began to exhibit a number of major shortcomings. Some of them came as surprises to us. Its toxicity, for one thing. This is the primary consideration here. What is more, YeZhS has proven to be unprofitable. It is almost twice as expensive as LZ-TsNII. To recoup the costs involved in using this material, a car would have to be operated for 800,000 kilometers without before being replaced. This is not realistic. It can now be said that this type of lubricant does not have much of a future.

[Question] If there's no future for YeZhS, then you obviously must be looking for another material, something of better quality, something more promising, something that doesn't cost as much. What can your division promise the car makers over the short term. Share your plans with us, if you would.

[Answer] We do have plans, of course. Aleksandr Viktorovich Nesterov will discuss these with you in more detail.

[Nesterov] The experts in our laboratory have been working on a more economical lubricant for a long time now. This search has not been abandoned even a day. And it has yielded some unexpected results.... A new material, which we are calling Buksol for now, has been shown to be superior to all previously known materials. We have been able to establish a set of "wear-free" conditions, conditions under which the bearings do not corrode. Our task, however, has not been simply to develop a less costly lubricant. We have also had to take account of the raw material resources available and use components which we are not going to find in short supply not only tomorrow, over the long term as well. And then of course we also had to take account of the capacities of today's rolling stock.

The testing is almost completed. We have been able to reduce the coefficient of friction by many times. Look at this (at this point Nesterov spreads some photographs out on the table). Here you can see the ends of some rollers which had been in operation with YeZhS. (The surface of the these parts is scored and pitted.) And here are the same rollers, but this time lubricated with a modified, general-purpose lubricant. (This is really amazing, but the photographs show a completely smooth surface, one that makes it look like the roller has been reworked and polished.)

[Question] But isn't this really just a reworked roller?

[Answer] No, it isn't. That's the whole point here. It is as though the new lubricant has "healed" the damaged part.

[Question] Amazing! So your new product isn't just a lubricant; it's also a kind of medicine for parts in sliding contact.

[Answer] That's about what we've got here.

Nesterov smiled.

[Answer (Gaikin)] It's too soon to be speaking of any final results, of course. But we have high hopes. Here at the institute we are conducting our tests under the most rigorous of conditions. The probability of such loads occurring under actual operational conditions is one in a thousand. We have observed an interesting phenomenon during the course of our testing. The components of the bearing become enveloped by a modified layer, such that when the lubricant is removed the assembly can continue to function without suffering any damage for another hour and a half. Scientists are still studying this "mysterious" layer.

[Question] So the introduction of Buksol is clearly going to entail some kind of reorganization of the system by which we manage and handle our rolling stock?

[Answer] I would like to take a closer look at precisely this question. The fact is that the lubricants we are using today can be removed from an assembly easily with water. The new lithium lubricants, however, repel water, which means you can't remove them with water. Terminal managers have to be ready for this. This is going to require the modernization of the machines we use to wash our roller bearing axle boxes and new cleaning solutions. We are also going to have to improve the operating condition of our water purification systems.

We have to begin these preparations during the present five-year-plan period. The new lubricant is going to be finding extensive application by 1988 or so. And probably by 1990 we will complete the transition to this new material. It is in the interest of all of us to make the time required to introduce Buksol as short as possible.

8963
CSO: 1861/24

DEVICE FOR TESTING INDUCTION IGNITION COILS DEVELOPED, NEVER INTRODUCED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 29 Jul 86 p 2

[Article by I. Mozgovoy]

[Text] A device was developed, the first of its kind. This happened 13 years years ago, but the device has not been introduced in production yet.

Reliability of parts and systems is one of the most important features of a modern motor vehicle. To sit and wait until a component unexpectedly fails is not the best possible tactics in this age of scientific and technical progress. It is much simpler and much more economical to predict reliability or to troubleshoot a problem at the assembly conveyor...

Professionals know: not every ignition coil performs its functions "conscientiously". Therefore, the problem of controlling its operation has always been given a lot of attention. Back in 1973, the USSR State Committee for Inventions and Discoveries [Goskomizobryetyeniy] issued a Certificate of Authorship No 366276 for the invention "Device for Testing Induction Ignition Coil (applied for by NIIavtopriborov [Scientific Research Institute of Automotive Instrumentation]). Later, in 1977, this device was successfully demonstrated at the VDNKh SSSR [USSR Exhibition of National Economy Achievements] and was awarded a silver medal.

The device provides on-line diagnostics and prediction of possible ignition coil or capacitor failures. Depending on application, two modifications were developed: for quality control directly on an assembly conveyor and for on-line use in operating conditions.

The device is relatively simple. It can be manufactured by virtually any automotive plant, at large and small automotive service enterprises, in experimental departments of design-technological automotive service bureaus - anywhere where there is a professional, knowledgeable in industrial electronics.

It would seem, that the uniqueness and high efficiency of the device should have drawn attention of Minavtoprom [Ministry of Automotive Industry] and RSFSR Minavtotrans [Ministry of Automotive Transportation]. Indeed, Minavtoprom conducted comparative tests. NIIavtopriborov findings were

positive. But there it stopped.

In the automotive industry, there are two different attitudes toward the device. Some organizations, for instance, enterprises, that manufacture ignition coils, are scared of the novelty as of a too rigorous QC inspector (it will generate more rejects, you know!). Other organizations, for instance, automotive plants, such as AZLK [Automotive Plant imeni Leninskogo Komsomola, Moscow] and AvtoVAZ [Volzhskiy Automotive Plant, Togliatti], sort of showed interest, but on the condition, that somebody else manufacture the device. In order not to rack brains over the problem, the following decision was made: because the device is "more" related to operation and maintenance of motor vehicles, let Minavtotrans implement it.

But reasoning of those in Minavtotrans was as follows: as long as the device is needed by automotive operating enterprises, let them manufacture it for themselves. And indeed, in spite of their more than modest means, some automotive operating enterprises made the device and successfully use it. In each case, savings were enviable. However, difficulties, that are only natural under semi-primitive production conditions, soon overcame the pioneers, and, as a result, the obvious benefits gave way to inevitable losses.

As a result, instead of a business-like solution of the problem of industrial implementation of new technology, the fate of the very much needed device, that is nonpariel both in our country and abroad, was finished.

In the meantime, "electronization" of motor vehicles is gaining momentum. The authors of the PTB-KO 69 device are prepared to it: after slight modernization, the device can be used for failure prediction in modern ignition systems, such as electronic ignition in a "VAZ-2108" car. The positive decision by Goskomizobrytyeniy has been issued.

But even now, not everything is lost yet. With a business-like approach by the above mentioned Ministries, one can if not make up for the lost time, at least considerably cut the losses by quickly starting production at a specialized enterprise... if one wants to.

12770
CSO: 1861/532

ACADEMICIAN KADOMTSEV: TOKAMAK OFFERS BEST ALTERNATIVE

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 17, 2-15 Sep 86 p 6

[Article by A. Mikhaylov: "A Step Towards Thermonuclear Fusion"]

[Text] An international design of a thermonuclear reactor has been developed for several years at the initiative of the USSR and with the participation of scientists of several governments. Development of this reactor would contribute to solution of the energy problem through the use of the "terrestrial sun" and would be capable even during the present century of providing mankind with an exhaustible source of energy.

A conference of the Technical Committee on the Technology of Nuclear Reactors of IAEA was convened in the summer of last year at Yalta, at which approximately 100 scientists from different countries participated. More than 60 reports, in which the results of the latest experiments were outlined, were presented and ideas were advanced that permit a new view towards the future of controlled thermonuclear fusion.

The problems of "thermonuclear fusion" now excite many people. A significant part of the readers of NTR: PROBLEMS AND SOLUTIONS and also the main readership of the journal ENERGIYA: EKONOMIKA, TEKHNIKA, EKOLOGIYA is interested in it. This also determined the thinking of simultaneous joint publication in our bulletin and in the popular science journal of the Presidium of the USSR Academy of Sciences.

The director of the Soviet part of the INTOR project Academician B. B. Kadomtsev talks about the status of thermonuclear research on our pages and in the journal ENERGIYA (No. 9, 1986) at the request of two editors.

Investigations to develop the tokamak-15 are entering the final phase at the Institute of Atomic Energy imeni I. V. Kurachatov.

The history of research on controlled thermonuclear fusion is a little more than four decades old. The development of science, primarily of nuclear physics, made it possible even during the late 1930's, to approach an understanding of the processes occurring on the sun. Matter, "burning" for billions of years there, is a plasma, a special gas, consisting of positively and negatively charged particles. Thermonuclear reactions: the nuclei of light elements are combined or fused, liberating enormous energy, occur in this

plasma, compressed by the powerful forces of gravity inside large celestial bodies--stars--and heated to millions of degrees.

One can gain an idea of the energy efficiency of this process with the following comparison: 750 tons of coal or 400 tons of oil or 250 grams of uranium-235 are required for an electric power plant with capacity of 1 million kilowatts to operate for 1 day. Deuterium--heavy hydrogen--is a universally available fuel and its resources are essentially unlimited. Thermonuclear reactors are considerably safer than nuclear reactors, while the number of radioactive wastes, especially elements with long half-life, are far fewer in these reactors. The mastery of thermonuclear fusion will make it possible to solve the energy problem for many decades and with minimum disruption of the ecological equilibrium in nature.

All this can be achieved if "stellar matter"--plasma--is created on earth and if we learn how to control the processes in it. As early as 1949, the American physicists H. Gamov and W. Critchfield stated that this problem can hardly be resolved technically. However, within several years, Soviet investigators proposed the intelligent method of confining the plasma by using a magnetic field. Independently of them, English and later American scientists arrived at the same idea. Thus began the start of investigations, the equal to which has never been known in scientific and engineering difficulties. Construction of different installations was begun in the USSR, England and the United States. It seemed that one more step and the problem would be solved.

However, since then an entire generation of people has grown up, to whom the word "thermonuclear fusion" has been known since school days, while the thermonuclear power plant is not yet a reality. There is one curious paradox here. As is known, the planet's first nuclear reactor was started up in 1942--it proved the principal theory of the atomic reaction of nuclear fission. Thirty years later, the atom has also shown its strange face at Hiroshima and Nagasaki. And 9 years later, the peaceful atom was operating in the "furnace" of the world's first Soviet nuclear power plant. Such is not the case in the thermonuclear problem. The thermonuclear bomb was initially developed. Experimental detonation of it confirmed the correctness of the scientific ideas and capability of producing enormous energy by this method. But there is as yet no reactor in which controlled thermonuclear fusion can be implemented.

Every needs a solution to this problem. It was then natural for the "entire world" to work on it, having removed the curtain of secrecy from thermonuclear fusion. The Soviet government was guided by this, when 30 years ago in 1956, it entrusted Academician Igor Vasilyevich Kurchatov to read the report "Thermonuclear Research in the USSR" at Harwell (England). The next day, all the world's newspapers wrote that the report had amazed scientists, that the Soviet investigator had talked about experiments which had already been completed in the USSR, while they are only being planned in England, and that the director or the Soviet nuclear program had presented all details for using the methods, illustrating them with formulas and numbers, which were considered absolutely secret in England and the United States. Academician Kurchatov, in the name of the Soviet Union, called on the governments and scientists of the entire world to enter investigation of the problem, mankind's most important problem. The contacts which were later established between investigators

involved in thermonuclear fusion accelerated considerably the solution of many key problems. The Soviet Union has continued over the past decades the policy toward internationalization of thermonuclear research. The Soviet Union made a new important step in this direction in 1978, it came out with the initiative of the international project INTOR (international tokamak-reactor). A working group of scientists and engineers of the member countries of Euratom, the USSR, the United States and Japan was created for this purpose at Vienna at the International Atomic Energy Agency (IAEA).

What problems did our group face? They were primarily to determine the designation and main characteristics of the thermonuclear installation, which it was proposed to construct on an international cooperative basis. Further, experts from different countries were supposed to evaluate the real readiness of the industry of interested governments toward practical development of it in the early 1990's and also to plan and coordinate a list of all future experiments. And, finally, a detailed design of the installation, experimental programs on it and development and operation of an experimental model were to be worked out.

I would like to emphasize that an international tokamak is not an industrial reactor. Its thermal capacity is comparatively low--approximately 50 megawatts. But all the main subsystems of future thermonuclear power plants should be tested on this installation and the real possibility of producing energy through controlled fusion of nuclei was supposed to be demonstrated.

Active investigations on the thermonuclear problem in participating countries of this international project and meetings of participants of the working group, held regularly at Vienna, led to a significant shift in solution of many scientific and engineering problems.

The final result of the first phase of this enormous joint work was published in a monograph, which became a unique encyclopedia of all that was known to science in thermonuclear fusion. Our group published two more volumes after this. One of them contains a summary of all solutions (naturally preliminary), which have already been proposed for the design of a thermonuclear reactor. Another volume is devoted to critical analysis of the proposed design solutions and their "bottlenecks."

But our participation in solution of this problem is of course not limited to international initiative and publication of the results of our own papers. Soviet science has made a significant and in some cases a decisive contribution to this important matter. It is no accident that the tokamak, which was developed many years ago in the Soviet Union, was selected as the main configuration of the INTOR project. This path was also taken as the basis by investigators in the United States, Japan and a number of western European countries. Tokamak-7 and tokamak-10 were constructed and tokamak-15 is under construction in the Soviet Union and the J-T-60 system is under construction in Japan. The TFTR thermonuclear installation became operational in the United States 2 years ago. The joint efforts of the member countries of Euratom made it possible to start the JET installation into operation in England. This installation is approximately of the same class as other reactor designs based on tokamak concepts. They proved their promise in a competition with other approaches to solution of the thermonuclear problem both in the Soviet

Union and abroad. Soviet scientists have also entered the results of their own research into the "international thermonuclear pot" in problems of plasma stability, its interaction with the walls of chambers, energy removal released during the reaction and much more.

Our attention is now devoted toward development of the tokamak-15 (T-15) installation, in which research and experiments will be conducted in the 1980's and 1990's. It is being constructed at the Institute of Atomic Energy imeni A. V. Kurchatov. More than 100 Soviet enterprises are participating in manufacture of the required equipment for the T-15. The construction work has now been completed in the experimental room and installation work is under way. I will admit that not everything is proceeding smoothly. There are difficulties. They are mainly caused by the fact that such unique equipment has never before and nowhere yet been developed and produced. We are talking here, for example, about the superconducting electromagnetic system for the T-15 installation. But regardless, one can assume that construction of this installation is entering the final phase. Transition to scientific research will follow.

The experience accumulated by many countries in thermonuclear research is a good foundation for continuation of investigations on the international reactor. It is now a matter of correctly and sequentially organizing, planning and solving a number of engineering and production problems, now faced by the international community of scientists. We are convinced that a thermonuclear reactor can be developed by the end of the century with this approach. And the time will come later for designing industrial thermonuclear power reactors and of using the controlled thermonuclear reaction to produce enormous quantities of energy.

Soviet scientists have proposed an interesting concept of the so-called hybrid thermonuclear reactor, which, along with electric power, will also produce plutonium. These installations will become an essential element of power engineering of the comparatively near future.

One can say that a new impetus has now been given to controlled thermonuclear fusion. The leaders of the Soviet Union and the United States, at a meeting of M. S. Gorbachev and R. Reagan, held in November in Geneva, decided to make a joint approach to a number of other governments with a proposal to conduct investigations in this field.

Implementation of this idea, as M. S. Gorbachev said at a press conference, "can open an interesting page in an extremely important area--providing mankind with an essentially inexhaustible source of energy. This is a field for joint activity." With regard to us Soviet scientists, we have always advocated universal development of cooperation in all fields of thermonuclear research, directed toward the good of all people of our planet.

6521
CSO: 1861/62

ULTRASONIC MECHANIZED CHECKING OF WELD JOINTS OF NUCLEAR POWER PLANT EQUIPMENT

Moscow ENERGETIK in Russian No 7, Jul 86 pp 20-21

[Article by engineer V. M. Lantukh, engineer M. Z. Tayts and Candidate of Technical Sciences V. S. Grebennik, All-Union Heat Engineering Institute imeni F. E. Dzerzhinskiy]

[Text] The ultrasonic checking method (UC) is used extensively to detect nonpenetration joints in the equipment metal during installation and operation of nuclear power plants. The ultrasonic checking method is now conducted mainly by hand due to the absence of serial mechanized and automated equipment.

Investigations directed toward solution of the problems, related to automation and mechanization of the ultrasonic method of checking metal during operation of the equipment of nuclear power plants, have been conducted over a number of years in the USSR and abroad. Thus, for example, special guides in the most stressed and, accordingly, the most potentially hazardous spots for securing universal modules, remotely connected to the stationary apparatus, and precision scanning modules are made during manufacture abroad (United States, Sweden, Federal Republic of Germany) for use of automated systems for checking the metal of nuclear power plant equipment.

Original automated systems for ultrasonic checking have been developed in the Soviet Union to solve special problems at the level of experimental or experimental-industrial models. For example, systems have been developed for ultrasonic checking of the reactor vessel from the outside and for the pipe connections of the reactor; some systems have been developed for mechanized and automated ultrasonic checking of the ring and longitudinal joints of pipelines and vessels of nuclear power plants and the UDTs-23M experimental automated unit has been developed for ultrasonic checking of the annular joints of pipelines.

Checking with some restriction of its universality can be mechanized in the first phase of developing ultrasonic checking systems. According to the technical assignment, compiled with the participation of VTI imeni F. E. Dzerzhinsogo [All-Union Heat Engineering Institute imeni F. E. Dzerzhinskiy] the UD-92EM mechanized flaw detector was developed and has been produced serially since 1985.

It consists of an electronic module, attachment, pulsed indicator of the scanning step and three MS-1, MS-2 and MS-3 scanning mechanisms. The weight of the flow detector with one scanning mechanism is not more than 16 kg. However, a unified approach to understanding the principles embedded in the design of the instrument with regard to the requirements of normative documentation used at nuclear power plants, must be worked out for use of this flaw dector on specific equipment. Therefore, the "Methodological Instructions on Ultrasonic Checking of Welding Joints and of Anticorrosion Surfacing of Automatic Synchronization Equipment Using the UD-92EM Flaw Detector," which established the requirements on organization, technique and formulation of the results of mechanized ultrasonic checking using the flaw detector, and also requirements on the qualifications of the checking personnel and analysis of the state of the metal of weld joints and of anticorrosion surfacing from the results of checking were worked out at the All-Union Heat Engineering Institute imeni F. E. Dzerzhinskiy according to the general manual on operation of the UD-92EM flaw detector.

The methodological instructions envisioned the use of the UD-92EM serial mechanized flow detector with special pickups, which emit transverse waves at frequency of 2.5 and 5.0 MHz and longitudinal waves at frequency of 2.5 MHz. The prism angle of the inclined pickups is equal to 40, 50 and 53°.

One can use serially manufactured pickups (see Figure) with emission frequency of 1.8 MHz and with prism angle of 30, 40 and 50° (P121-N3) in the flaw detector, which considerably expands the range of its application.

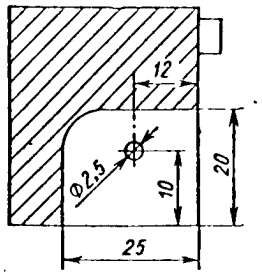

Diagram of Modified Pickup with Emission Frequency of 1.8 MHz

A mechanized check of the butt joints of sheet structures from 8 to 100 mm thick, of annular and longitudinal joints of vessels with outer radius of curvature not less than 500 mm and of carbon or low-alloy (perlite) steel pipelines with outer diameter not less than 850 mm is possible by using the UD-92EM flaw detector.

Weld, annular and longitudinal joints of the steam generator vessels of nuclear power plants (with the exception of weld joints on the thickened part) with VVER-440 reactors, the point of welding the bottoms to the cylindrical part, longitudinal and annular weld joints of steam generator vessels of nuclear power plants (with the exception of weld joints on its thickened part) with VVER-1000 reactors, annular weld joints of D_y = 850-mm pipelines, annular and longitudinal weld joints of D_y = 1000- and D_y = 800-mm headers and the vessels

of drum separators of nuclear power plants with RBMK-1000 reactors and the annular and longitudinal weld joints and bottoms of the drum separator vessels of nuclear power plants with TVGE.2 reactors is possible, for example, by using the proposed flaw detector.

The pickup automatically scans the weld joint transversely, while longitudinal scanning is manual, which permits an increase of the productivity and safety of making the check under the operating conditions of the power plant.

The operator scans the weld joint longitudinally by manually moving the scanning mechanism.

The given scanning step in checking the weld joint or anticorrosion surfacing is checked by using the pitch indicator pulser. The scanning pitch for pickups with frequencies of 1.8, 2.5 and 5.0 MHz should be equal to 9, 6 and 3 mm, respectively. When using an inclined pickup for checking the weld joints of pipelines, vessels and sheets with base metal thickness of 40-100 mm, the frequency of the sounding pulse transmissions should be 300 Hz and in the remaining cases it should be 1,000 Hz, which permits more rapid checking.

During checking, the scanning mechanism carriage is installed in the rotational mode of the pickup at an angle of ±15° with respect to the normal to the joint at the end of each displacement.

A transverse scanning governor of the pickup from 0 to 10 mm/s is provided in the accessory to the electronic module of the flaw detector. The rate is selected as a function of the type and thickness of the product (the rate decreases with an increase of thickness).

A check is conducted on search sensivity. If a flaw is detected or if there is unclear determination of its rejection features, a second detailed examination is made manually.

Time sensivity regulation (TSR) modules and automatic flaw signaling devices (AFS) (audio devices with regulated loudness and light devices) are installed in the UD-92EM flaw detector. They are adjusted at the check level of sensivity.

Digital readout modules are placed on the front panel of the instrument. The digital displays permit one to fix time indicators in microseconds and coordinate indicators in millimeters (the depth of deposition, coordinates, conditional length and height of the flaw) for direct and inclined pickups.

The outer surface of the product is machined to make the check.

The width of the prepared zone depends on the type of equipment to be checked, on the type of weld joint, on the thickness of the base metal, on the prism angle of the pickup and on the sounding circuits. It is regulated by Methodological Instructions.

Mechanized ultrasonic checking by the proposed method is being performed for the first time at Soviet nuclear power plants.

Experimental testing and introduction of the flaw detector and of the Methodological Instructions was completed at a number of nuclear power plants in 1985.

6521
CSO: 1861/26

EXPERIENCE IN PREPARING AND CONDUCTING THE OVERHAUL OF A K-1000-60/1500 TURBINE SET

Moscow ENERGETIK in Russian No 6, Jun 86 pp 21, 22

[Article by I.P. Krasnikov, L.M. Valavin, engineers, Yuzhenergoremont]

[Text] In 1984 the Yuzhenergoremont enterprise conducted the first overhaul of a pilot model Kharkov Generator Plant K--100-60/1500 turbine of the Southern Ukrainian AES with the modernization of the first stages in the three low pressure cylinders. Overhaul of the medium- and high pressure cylinders was not included in the project.

Due to the long and technical preparation, during which a whole series of serious organizational and technical questions were solved, the overhaul was completed in 68.5 calendar days, the time planned for the project having been 70 days.

In the first phase, along with the organization of the overhaul site, the paperwork for the overhaul was basically completed (procedure and technical specifications for turbine overhaul, technical specifications for overhaul of the pumps in the turbine room, and design documentation). These documents made it possible to determine the scale of the project and to manufacture new, specialized technical rigging and organizational equipment.

In accordance with the plan for organizational and technical measures, plans for 76 different types of equipment to be used in the overhaul were prepared, including 38 pieces of equipment developed in the enterprise's design bureau. Fifteen pieces of equipment were manufactured at the enterprise.

Primary attention was then focused on the staffing of overhaul teams, their training in the use of the large-scale machinery necessary for the overhaul, organization of turbine subassembly work sites, and continuation of the design and production of equipment. The design group of the Yuzhenergoremont turbine shop alone developed some 100 types of special equipment and 18 organizational and technical documents.

Unfortunately, not all problems could be resolved by the enterprise itself. For example:

When the overhaul equipment was set up in the turbine room, no space was provided for spreading out the parts of the turbine and generator (either major subunits or individual parts) during the overhaul. Thus, the space actually required for parts with a unit mass of 10 tons per square meter was 3,000 square meters; and for 2 tons per square meter, 1000 square meters. The actual areas available were 940 and 470 square meters, respectively.

The bulk of the auxiliary equipment was installed without consideration for the standard hoisting machinery used; in individual instances disassembly of metal parts caused great losses of labor and additional time. Of the 32 hoisting mechanisms envisioned for the project, only 5 were assembled in the turbine room.

The question of manufacturing and acquiring of heavy duty straps (for 3 tons and heavier) and specialized measuring equipment for large objects was not resolved.

Due to a shortage of metal, not all of the planned equipment was produced.

Moreover, the turbine at station no. 2 was being installed at the time of the overhaul of the turbine at station no. 1. For this reason, only 2 of the 4 bridge cranes were in continuous use at the overhaul site. All standard equipment for the overhaul of the turbine and its feeder pumps was under the control of the installation crew and was given to the overhaulers only on the day it was to be used by them. The overhaul personnel thus did not have adequate time to modify the equipment and learn to use it.

The most demanding and tedious part of the overhaul was the replacement of the diaphragms and movable blades of the first stage low pressure rotors with new blades and accurately milled shrouds.

Blade replacement was carried out in situ with 5 machined, grooved, 6 mm diameter assemblies of blade shafts on disk flanges. Machining was conducted while the shaft was within its bearings, for which the low rpm shaft turning assembly was replaced with a 4 rpm model. For this purpose lathing, milling, and polishing machine tools were set up alongside the stand on the overhaul site.

The movable blades arrived at the power plant from the factory already arranged on dummy disks, thus substantially reducing the effort required for their preparation.

A unique feature of this job was that during machining the rotors were turned with the help of a hydraulic lift; therefore, it was possible to begin overhaul of the lubrication system only after the disk flanges had been machined. After reblading, however, the lubrication system had to be in working condition before the rotors could be overhauled.

Another feature of the turbine overhaul was the great volume of metal equipment (large, heavy subunits and individual parts), and also the unusually large number of fastenings (several thousand).

The following presented certain difficulties: the disassembly and reassembly of the rotor half-couplings; the aligning of the half-coupling apertures during insertion of beveled pins; and the rolling out of heavy bearing inserts all of which required the manufacture of special equipment. None of this was anticipated when the procedure for the overhaul was being worked out, and therefore actual labor expenditures for the overhaul of individual subunits diverged from the estimates by a factor of 8 to 10.

A unique feature of the organizational plan for the overhaul was the necessity of concentrating a maximum of personnel directly on the disassembly of the turbine in the first 7 days. This was done by enlisting the help of the teams involved with the overhaul of auxiliary equipment. Another essential for completion of the overhaul on time was the organization of the tasks into three shifts using a sliding timetable.

Turbine No. 2 was overhauled in 1985 with an analogous amount of work. The overhaul was completed in 51.5 days. A reduction of the most critical work facilitated the reduction in the timespan of the overhaul compared with Turbine No. 1. For example, excluded were those jobs connected with the removal and overhaul of the generator rotor; and the experience acquired during the first overhaul showed in no small degree. The overhaul personnel had had 4 bridge cranes at their disposal in 1985, a large part of the equipment supplied by the factory had been made available on time, and especially important equipment had been prepared.

Considering the experience of the Yuzhenergoremont enterprise in preparing and carrying out the overhaul of nuclear power plant equipment, the following conclusions and suggestions can be made:

1. It is essential that the processing of technical documentation for the overhaul of new equipment be begun 2-3 years before the beginning of the overhaul, and the development and production of equipment and apparatus and the staffing and training of overhaul personnel must be done before the beginning of the overhaul.

2. Manufacture of equipment for the overhaul of nuclear power plant equipment to be reintroduced should be given to factories of the Soyuzatomenergo All Union Production Association along with limits for materials. Manufacturers should develop and produce special equipment for overhaul of turbines and auxiliary equipment and deliver it along with the original equipment.

3. It is essential to harmonize the centralized production of heavy duty straps and of special measuring equipment for large components and assemblies for heating of connecting pins, high and medium pressure cylinders, and partly, of low pressure cylinders.

4. It is essential that the Special Design Bureau of Soyuzenergoremont see that the equipment is adequate for overhauling nuclear power stations that are being rebuilt and provide conditions necessary for normal work for overhaul personnel.

13320
CSO: 1861/501

UDC 697.92

VENTILATION OF AIR-TIGHT COMPARTMENTS

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 2, Apr-Jun 86 pp 16-18

[Article by Candidates of Technical Sciences P.I. Stepanenko and V.F. Vlasik and Engineer V.V. Konsovskiy, YuzhVTI]

[Text] The widespread construction and commissioning of powerful power units calls for intent studies of ventilation problems, because, in addition to purely sanitary-hygienic purpose of ventilation, some principally new technological problems have now appeared. Cases are known in which high-power generating units had to be taken off-line for several days only because of poor operation of ventilation systems.

Air-tight compartments are a necessary component of process flow diagrams of power plant units. Combined with general ventilation by dilution, process and special ventilation, they help localize thermal, dust, gas and aerosol hazards, create directional air flows, organize microclimate with specified environmental parameters, etc.

In order to study specific features of ventilation of air-tight compartments, a special stand has been developed at YuzhVTI. The base of it is an air-tight box with overall dimensions (5 x 3 x 2 m), comparable to those of real-life air-tight compartments. The exhaust system of the stand consists of a 240 x 250 mm metal air duct, that connects the box to ventilating unit Ts4-70 No 3, 15. Air supply can be provided either from the room, where the box is installed, or from atmosphere through doors and/or 100 mm diameter inflow air ports, whereas exhaust is provided through 200 mm diameter exhaust ports.

The stand makes it possible to simulate ventilation modes of the majority of special compartments, such as air-tight, semi-air-tight (with pressure relief valves), periodically serviced compartments, etc.

Box walls are made of 90 mm thick foam-concrete plates; the walls are plastered inside and have 1.5 mm thick steel sheet siding on the outside. Thermocouples (TKhK, TKhA, 0.2 mm diameter) are installed at various heights in various places on inner surfaces of walls.

In order to measure air temperature at various points (length- and height-wise) inside the chamber, a system of mobile thermocouples is provided. EMF

is recorded by PP-3, EPP-09 M and KSP-4 potentiometers. For visual studies of air flows (streams), the stand has a device for point injection of cold smoke (aerosol, formed as a result of combination of NH_3 and HCl vapors) and a system of light ribbons. Industrial cool light bulbs are used for general illumination, whereas light sources, based on low-power incandescent bulbs, were used for point illumination.

Air velocities in air flows (streams) were measured with a TA hot-wire anemometer.

A smoke candle was used to create smoke pollution. In order to standardize initial conditions, the same amount of candle (50 g) was burned at the beginning of every experiment.

In 7 min the box was uniformly filled with smoke. The specific feature of this aerosol is that even a small amount of it, that escapes from an air-tight compartment, can be detected by its color and odor. The latter is very important when one studies the effect of vacuum in the box on propagation of hazards, the efficiency of increasing air circulation ratio, etc.

A model of heat generating device with a 6 kW input was used as heat and humidity source. The model can be freely moved inside the box, and wall temperature can be changed within a wide range.

A DMP-235M smoke meter was used for recording the efficiency of each ventilation method (the time to "clear the smoke" in the box). A "Volna-2M" hygrometer was used to record air humidity changes.

The stand was used for experimental studies of modes of ventilation of air-tight, semi-air-tight and non-air-tight spaces in the presence of heat and humidity inputs, free airing, aerosol removal, etc.

The experiments have proved the assumption that increasing the air-tightness of a compartment leads to lower efficiency of ventilation thereof and to the increase in power consumption by a fan. The character of air stream motion is significantly different from free ventilation modes. Due to "unorganized" random air supply, the chaotic character of streams increases, their intensity decreases, pressure gradient profile at the exhaust port changes, and the time necessary to remove hazards sharply increases.

Thus, when the volume of exhausted air (during a one-hour period) is 30-40 times higher than the box volume, it takes about 15 min to completely remove hazards, i.e. ventilation efficiency is reduced by a factor of 7 to 10. Hence, when hazards are supplied into the box on a consistent basis (which is the case in real life), it is impossible to provide reliable removal thereof without taking special measures, directed at intensifying the process.

One of the methods for intensifying hazards removal is air turbulization by forced streams energy (Figure 1). In this case, due to lower than environmental pressure, compartments are considered air-tight. Such compartments usually have pressure relief valves that seal the compartment when the vacuum inside reaches a permissible, predetermined level.

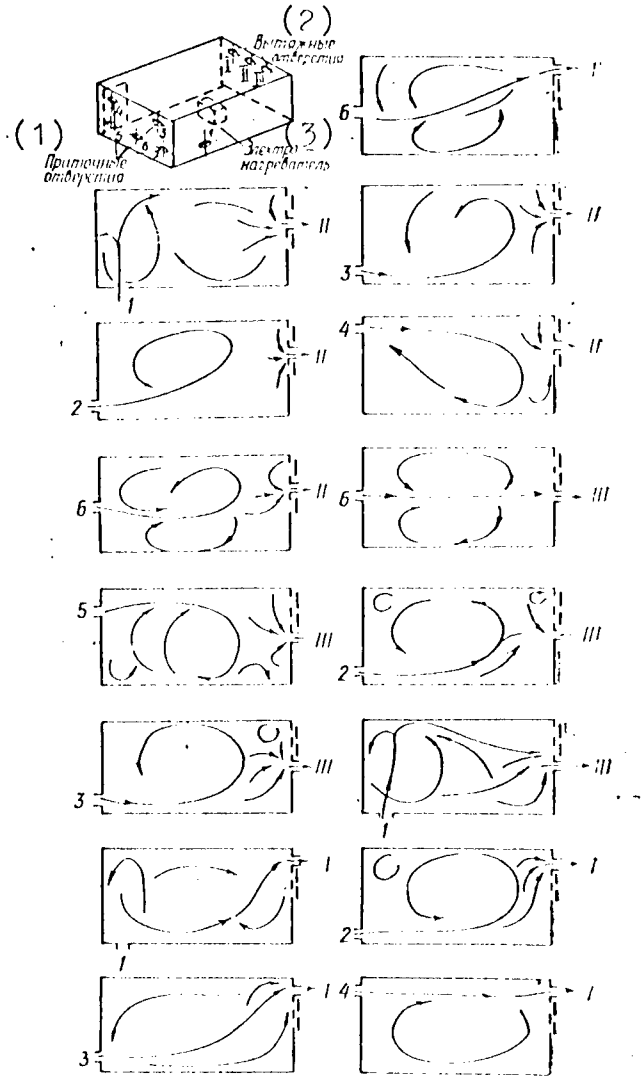

Figure 1. Diagrams of Air Motion in Compartments for Various Combinations of Relative Positions of Inflow and Exhaust Ports in Absence of Heat Dissipation: 1-6 - inflow ports; I-III - exhaust ports.

Key:
1. Inflow ports
2. Exhaust ports
3. Electrical heater

Various combinations of relative positions of inflow and exhaust ports were used. It has been determined, that it is difficult to achieve high level of ventilation of air-tight boxes by only using inflow streams. Inflow streams considerably affect the character of air motion in the box, but have little effect on the intensity of hazard removal. Physically this can be explained by the fact, that at a distance as low as 2-3 exhaust port diameters air velocity towards the port is close to zero. On the other hand, intensive

agitation of hazards in the box air by the inflow stream impedes their precipitation in one assigned area. If the inflow stream enters a compartment at high velocity, it can pass as transit directly through the exhaust port. In this case stream trajectory has relatively low effect on the quantity of removed hazards. Hence, for compartments with high release of "hazards" it is feasible to "design" the character of stream flow of ventilated air.

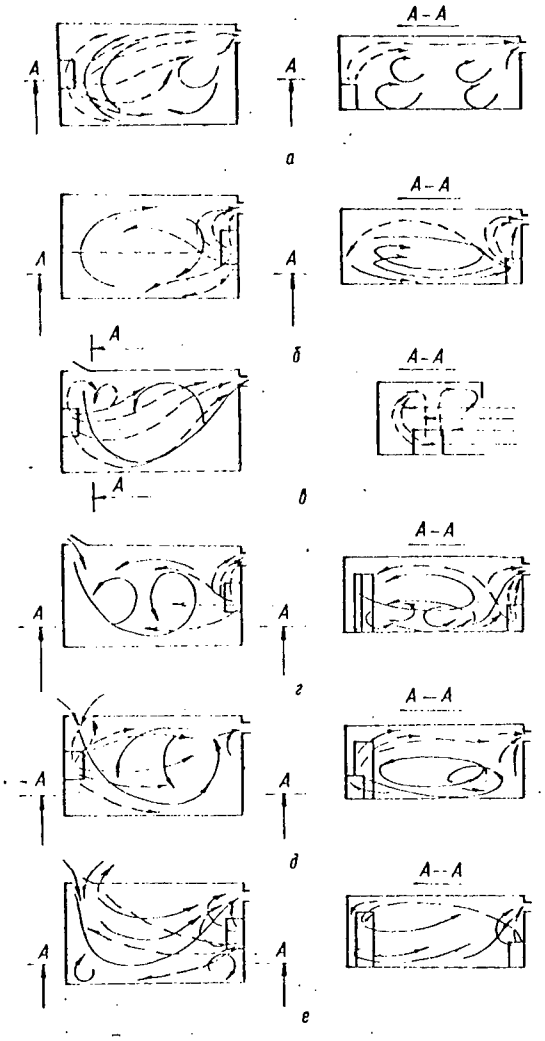

Figure 2. Diagrams of Air Motion in Compartment With Heat Releases in Case of Various Location of Heat Releasing Element and Various Degree of Door Opening: a, б - air-tight compartment; b, г - door set ajar; д, е - door open.

In the case of heat influxes the character of air motion inside air-tight compartments changes even more (Figure 2). Distribution of air flows (streams) is considerably affected by the heat source location, orientation and temperature, as well as by the presence and capacity of forced ventilation and by other factors.

Inflow, exhaust, cold and warm air streams form complex currents. They can increase box ventilation, decrease it or even bring it down to zero.

It should be specifically noted, that not only does a heat pollution source affect the ventilation of a compartment, it is also the main cause of hazard propagation outside the compartment.

It is difficult to determine the amount of leaks quantitatively, but under the experimental conditions neither ventilation ratio of 30 or higher, nor a 40 mmH_2O vacuum inside the box, nor the absence of visible channels connecting the box with the outside room, was sufficient to prevent aerosol leaks from the box into the room.

Noting considerable effect of the location of a heat releasing element relative to inflow and exhaust ports, we shall point out, that the possiblity of mathematical simulation of ventilation modes of air-tight compartments has been experimentally proved. Thus, for the case of an air-tight box, using multi-factorial experiment methods, a regression dependence between the ventilation of compartments and the following four factors has been determined: location of the heat releasing element, horizontal and vertical positions of inflow ports 2, 3, 4 and 5 and horizontal positions of exhaust ports I-III (Figure 1).

Conclusions

Distribution of air flows in a ventilated air-tight compartment, especially in the presence of heat releases, is considerably different from their distribution in non-air-tight compartments. Ventilation of such compartments in order to remove pollution is different from ventilation of non-air-tight compartments.

In order to achieve maximum effect in ventilating air-tight compartments, they should be designed with stream air motion inside, and equipment for local air treatment must be provided.

12770
CSO: 1861/466A

UDC 69.022.2:699.82:678.742.2.002.2

ORGANIZING INDUSTRIAL-SCALE PRODUCTION OF SHAPED POLYETHYLENE SHEET PARTS FOR WATER-PROOFING IN CONSTRUCTION OF NUCLEAR ELECTRIC POWER PLANTS

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 7, Jul 86 pp 32-33

[Article by V.D. Likhachev, candidate of technical sciences, K.I. Korenev, candidate of technical sciences, K.I. Chikvaidze, candidate of technical sciences, and M.B. Dzhurinskiy, candidate of technical sciences]

[Abstract] A low-density polyethylene sheet for water-proofing has been developed at the Donetsk Institute of Industrial Construction Planning. Shaped parts of this material are eminently suitable for use in nuclear electric power plants, for construction of vertical underground walls of the reactor housing. It is being used in several such power plants (Novovoronezh, South Ukraine, Rostov, Krymsk, Khmelnik and Zaporozhye), its total consumption amounting to about 600 t or 300,000 m^2 so far. It is being produced at the Yenkiyevo plant manufacturing reinforced-concrete pressure pipe. An increase of the nominal sheet width from the experimental 1884 mm to the present 3140 mm has reduced the number of splicing operations by approximately 50%. In view of the expected further demand of about 700 t or 350,000 m^2 annually, it is recommended that the production be better organized. Workshops should be set up and staffed specializing in production for nuclear electric power plants.

2415/9835
CSO: 1861/20

UDC 621.315.235

IMPROVING FIRE PROTECTION OF CABLES IN ELECTRIC POWER PLANTS

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 7, Jul 86 pp 33-34

[Article by S.Ye. Korshunov, engineer, and B.Z. Umanskiy, engineer]

[Abstract] Progressive automation of modern thermal electric and atomic electric power plants implies a heavier demand for fire-proof cables. An extensive study made at the All-Union Institute of Fire Protection has revealed that the major fire hazards in cables are mechanical damage done during installation or in service and initially imperfect or subsequently aged insulation. The most effective countermeasures include filling no less than 35% of the cross-sectional area of cable ducts with cables (to inhibit infusion of air and thus impede propagation of a flame through dense smoke); also better sealing, and inclusion of special fire-resistant strips 3 m apart in horizontal ducts and 20 m apart in vertical ducts. Figures 1; references 2: Russian.

2415/9835
CSO: 1861/20

UDC 621.039.51

DIGITAL REACTIVITY METER FOR NUCLEAR REACTORS

Moscow ATOMNAYA ENERGIYA in Russian Vol 61, No 2, Aug 86
(manuscript received 22 Jul 85, in final version 15 Jan 86) pp 110-113

[Article by A.V. Grachev, Yu.S. Kanunnikov, Yu.S. Kulabukhov, I.P. Matveyenko, Yu.L. Milovanov, Ye.N. Shipilov, and A.G. Shokodko]

[Abstract] Reactivity measurement in nuclear reactors is reviewed theoretically, on the basis of the corresponding generalized equation of kinetics in which the time-derivative of the detector function, multiplied by a delayed neutron exponential decay factor, is integrated up to some time t'. Piecewise-linear approximation of the neutron countr transforms the integrals into sums and leads to the concept of a digital reactivity meter. Space effects are accounted for by the detector efficiency function as a coefficient in the appropriate form. Such an instrument has been designed for operation with an Elektronika-60 microcomputer including an M2 microprocessor with 4 kB RAM and 8 kB of EEPROM based on series K573RF1 chips with UV erasure. The meter itself consists of a neutron detector, a CAMAC current-to-frequency converter, a pulse integrator-counter with a 0.2 s time base, and a time base generator with quartz-crystal frequency stabilization. Data processing has been programmed in FORTRAN and ASSEMBLER languages according to algorithms constructed on a MERA-60 computer, with the space-effect coefficient evaluated by the method of least squares so that a

space effect larger than 11% can be shut off. Figures 1; references 8: all Russian.

2415/9835
CSO: 1861/47

UDC 621.039.5.65.011.54.002.72

MECHANIZATION OF OPERATIONS IN NO 4 POWER UNIT OF KURSK AES INVOLVING INSTALLATION OF GRAPHITE PLATES OF COOLING CHANNELS FOR BLANKETS OF RBMK-1000 MW WATER-GRAPHITE CHANNEL REACTORS

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 8, Aug 86 pp 39-41

[Article by G.V. Filatkin, engineer, and A.D. Chulkov, engineer]

[Abstract] A new technology of installing graphite plates of cooling channels for reactor blankets has been devised which involves use of a special hoist and thus mechanizes the operations. The essential component of this hoist is a clamp for picking up and holding a graphite plate. Its gripping surfaces are lined with 1.5 mm thick aluminum sheet for better adhesion to graphite. Special arrangements are made to facilitate lifting a graphite plate together with the protective steel plate by using a pull rod, without damaging the graphite. The method was implemented in the No 4 power unit of the Kursk AES, with two such hoists in operation. It took 25-30 min to install one column of graphite plates and additional 15 min for auxiliary operations. One drawback of this method has been poor communication between working crews on upper and lower level of the reactor space. Figures 2.

2415/9835
CSO: 1861/43

UDC 621.039.5.624.014.621.791.7

TWO-ELECTRODE WELDING OF VERTICAL JOINTS WITH FORCED BUILDUP OF SEAM METAL IN ASSEMBLY OF METAL STRUCTURES FOR RBMK-1000 MW WATER-GRAPHITE CHANNEL REACTOR

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 8, Aug 86 pp 41-43

[Article by B.F. Lebedev, doctor of technical sciences, L.G. Kuzmenkov, engineer, G.M. Ginzburg, engineer, and M.I. Loskutov, engineer]

[Abstract] A technology of electric-arc welding of vertical joints with two electrodes and with forced buildup of seam metal has been devised for construction of nuclear reactor plants. The advantages of welding with two

electrodes are feasibility of making a joint in a single pass, overall simplicity and high productivity of the process, high quality of joints with stable mechanical properties of both seam and parent metal, and reliable gaseous or slag shielding of molten metal. The seam metal is formed from self-shielding powder wire. A critical factor determining the effectiveness of such welding is the distance between electrodes, 8-36 mm depending on the thickness of welded parts being the correct range. Experimental welding by this method was done with a special welding machine AD-102 built at the Institute of Electric Welding, voltage and current being varied over the 28-34 V range and the 550-950 A range, with PP-AN19s powder wire 2.35-3 mm in diameter and CO_2 shielding. The method was tested on 25-50 mm thick plates of low-alloy steels 10CrNilMo and 10CrSiNiCu. Series of II-form joints 500 mm apart were produced with not more than 2 mm warp. It was then tested in the field, on L-structures in the No 4 power unit of the Kursk AES. Experience here dictates that the range of welding process parameters should be narrowed down to 34-36 V and 750-850 A. Experience here also reveals several deficiences in the technique, namely poor reliability of the wire feed mechanism, lack of a hoist for the welding machine, and inadequate shielding of joined surfaces. It is recommended that welding be done without stripping the edges. Figures 3; tables 2.

2415/9835
CSO: 1861/43

UDC 624.012.454:624.012.5:62-192

RELIABILITY OF PREFABRICATED CAST WALLS UNDER CONDITIONS OF HEATING ON ONE SIDE

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 8, Aug 86 pp 69-70

[Article by A.P. Kirillov, doctor of technical sciences, T.V. Chernyak, candidate of technical sciences, and O.D. Rubin, candidate of technical sciences]

[Abstract] Special wall constructions have been designed at Gidroproyekt [All-Union Planning, Surveying, and Scientific Research Institute of Hydro Engineering Construction imeni S.Ya. Zhuk] for the purpose of accelerating and simplifying erection work in nuclear electric power plants and specifically plants with RBMK-1000 MW water-graphite channel reactors. These are prefabricated one-piece cast walls of reinforced concrete. Prototype sections of such walls were specially tested under conditions of unilateral heating from the reactor side, simulated by a temperature drop of 70°C (normal conditions) and 130°C (emergency conditions) across the wall thickness. In terms of thermal stresses and strains, cracking resistance, mechanical strength and rigidity, these constructions were found to be satisfactory at normal temperature and still safe at temperatures up to 130°C. Figures 1; tables 1; references 3: all Russian.

2415/9835
CSO: 1861/43

UDC 621.311:658.514.011.56:681.3

AUTOMATION OF PROTECTIVE ANTI-FAULT RELAYING ON BASIS OF TWO 'ELEKTRONIKA-60' MICROCOMPUTERS

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 86 pp 53-55

[Article by Ya.P. Tenenbaum, engineer, E.N. Kremer, engineer, E.I. Merport, candidate of technical sciences, A.I. Turkot, engineer, G.M. Khodos, engineer, Yu.A. Vakulenko, engineer, V.N. Matrosov, engineer, and G.V. Milyayev, engineer, Sredaztekhenergo [Central Asian Regional Power System Engineering Administration], Saratovenergo [Saratov Regional Power System Administration], and Saratov GES]

[Abstract] The automatic load-dropping system, operating on the basis of one Elektronika-60 microcomputer in the Saratov GES since 1982, is being supplemented with a second such microcomputer. This provides automatic standby and thus failure-proof protective anti-fault relaying, increases the interference immunity, facilitates redundant data acquisition for verification purposes, and eliminates electromechanical relays. Functions of this Elektronika-60 complex include gathering and processing of analog and discrete data, with classification of input signals into useful and nonoperational ones as well as into fast-varying and slow-varying ones. The output information consists of 16 analog and 60 discrete signals. Both hardware and software are designed for transmitting information about the state of the power system (normal operation, partial failure, total failure) over remote-control channels with TM-512 telemechanical equipment, to facilitate the RESTART procedure when called for, while also identifying the load-dropping stage and the correct astonomical time of information transmission. The new system is being tested and debugged. Figures 2.

2415/9835
CSO: 1861/53

UDC 621.039:536.4

HELIUM TEST STAND FOR DEVELOPMENT OF HEAT EXCHANGE EQUIPMENT OF POWER INSTALLATIONS WITH HIGH-TEMPERATURE HELIUM-COOLED REACTORS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 86 pp 23-25

[Article by Candidates of Technical Sciences V.P. Ivanov, I.K. Terentyev, Ye.D. Fedorovich, and Engineers D.M. Kalachev and V.N. Nekrasov]

[Abstract] The Scientific-Production Association of the Central Scientific Research and Planning-Design Boiler Turbine Institute imeni I.I. Polzunov has created a large-scale helium test stand for development of reliable power installations with helium cooled high temperature reactors, allowing testing of full-scale devices and models. The process of development, construction and testing of the stand equipment has required solution of

problems of sealing of helium, storage of helium and filling of the loop with helium, the use of helium pumps with oil-lubricated bearings and heating of helium to 800°C. Operation of the device is described, and a photograph is presented of the central control panel. Results of combined testing of an experimental double pipe and a section of steam generator for the VGR-50 unit have shown practically normal operation of the test stand equipment. The helium pump provided the necessary helium flow and operated reliably. Figures 3.

6508/9835
CSO: 1861/60

POWER BROWNOUT CAUSES, POST-CHERNOBYL OPTIONS EXAMINED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 30 Sep 86 p 1

[Article by V. Maslennikov, "Deviation on the Dial", "Interview with Letter in Hand"]

[Text] It is not the first time that engineer V. Dubovik of the Moscow area has written to the editor. It was he who brought to our attention the year before last the frequency fluctuations in the electric power network of the country. At that time, the frequency was 1.5-2 percent below that required by GOST [State Standards]. Our paper devoted several articles to the improvement of the quality of electric power.

Towards the end of last year, the frequency of 50 Hertz in the country's electric power network was restored. The USSR minister of power engineering and electrification, A. Mayorets, reported to the 27th CPSU Congress on the measures used to restore this frequency and on the effect the power quality increase on the economy.

But again we hear alarm signals: from the middle of this year, the frequency in the country's electric power network again beban to fall. Among the many letters to the editor on this subject there was also a letter from engineer V. Dubovik, whom we already know. "What happened?"--he asks--"In my opinion, references to the Chernobyl accident are not convincing if only because the frequency conformed to GOST a whole month after this event and then began to fall for some reason."

Our newspaper asked Ye. Petryayev, the director of Central Supervisory Control of the Integrated Power System of the country, to answer this question.

"The electric power frequency, like the pulse of a patient, is the most graphic index of the 'health' of the entire system," Yevgeniy Ivanovich glanced at the frequency meter installed directly in front of his desk. The fluttering numbers on the illuminated indicator board showed 49.32 Hertz. "You can see that the power quality in the network is below the norm. You know yourself that this is nothing to brag about. The situation is difficult. To put it plainly, we have a power shortage. There are many reasons for this, one of them being, of course, the Chernobyl accident."

[Question] But could the stoppage of one power plant, even as large as the Chernobyl Plant, have such a great effect on the entire system?

[Answer] "We made up the loss of production of one plant by mobilizing the excess capacity of other plants. Incidentally, your reader notes the frequency stability in May.

"But let us recall the conclusions of the government commission regarding the causes of the Chernobyl accident. In addition to the slackness of personnel and the departures from proper procedures of operation of plant equipment, they also noted design deficiencies. This means that some other nuclear power plants that have the same equipment also suffer from these shortcomings. Can we permit even the smallest risk of repetition of the Chernobyl tragedy? This is why a whole complex of preventive maintenance measures has been undertaken at several nuclear power plants. For this purpose, some power-generating units have been taken off-line, and work is being done to improve their safety and raise their reliability. The loss of this capacity, although temporary, is not that simple to make up.

"At first, relief was provided by hydroelectric plants utilizing the high spring-time level of the rivers. Then the river levels started to fall, and the situation became even more complicated. This is why we have deficiencies on the frequency dial."

[Question] How was it possible last year to increase the quality of the energy produced?

[Answer] "By mobilizing practically all of our temporarily idle capacity. We increased the power production and thus also its quality. We put into production about 10 million kilowatts of additional capacity, which was equivalent to starting up several new power plants. This was achieved by organizational and economic measures. First, operational and personnel discipline was strengthened in all collectives, and second, a new index for the evaluation of the performance of every plant was introduced. The first measure needs no explanation, but the second one does. The former principal performance index, consumption of fuel per unit of power produced, promoted the use of only the most economical equipment.

"Now performance is rated by the maximum utilization of equipment. Producing that "extra" kilowatt saved much more than that achieved by not producing it. This is beneficial for the entire national economy, for each kilowatt is converted to additional production in manufcturing. The power production workers also benefit. When the capacity utilization increases by one percent, the material incentive fund is increased by nine percent. A provision also exists for punishment with the ruble. If the capacity utilization falls by the same percentage, the material incentive fund is reduced by 12 percent."

[Question] And what stands in the way of full utilization of this economic action mechanism also at the present time?

[Answer] "It is operative. A previously idle 5.6 million kilowatts of capacity have been put in production. This, of course is less than at the beginning of the year, but nevertheless the addition is appreciable."

[Question] Nevertheless, the frequency is falling. Look, the counter already shows 49.12 Hertz.

[Answer] "No wonder. Do not forget that this is the maintenance season. It is impossible to avoid taking out of production some generating units or even entire plants."

[Question] Does it mean that we should resign ourselves to this situation?

[Answer] "Certainly not. But we should not assume that the quality of the power produced depends only on the wishes of the power-production workers. There is a conflict between the needs of the national economy and the possibilities available to the power industry. More power is demanded from us than we are capable of producing. We are forced to lower the frequency or to cut off some users."

[Question] What is the solution?

[Answer] "It lies in a more uniform load distribution. At night, we have excess of power. We can even supply it to the users above their quotas. There is a shortfall during the morning and evening peaks. We have high hopes that the enterprises will change their operation to two and three shifts. Thus far only the Ukraine, more than the others, works in two shifts. The possibilities of this maneuver are poorly utilized in Leningrad, the Baltic region, and in many other industrial regions of the country.

"Power consumption is a sensitive barometer. We can tell from the readings of our instruments where the unused reserves are. At many enterprises, it is sufficient to simply shift the most power-intensive processes to nighttime, and the electric power supply situation will improve immediately. For example, the supply to the entire industrial center improved when the shift change at the VAZ [Venyukovo Armature Plant] was made to a time recommended by us. Similar measures proved to be useful also in the Chelyabinsk Oblast. It is a pity that thus far these are isolated examples."

[Question] More plants than previously planned are presently being overhauled, adn the winter is not too far away. Aren't you concerned?

[Answer] "It is impossible not to be concerned! We are pushing the repair work by all means available. According to all predictions, a difficult winter is expected. The dry summer made it impossible to collect the necessary reserves in the reservoirs of the European part of the country, Transcaucasia, and Central Asia. Therefore the brunt of the load falls on the thermal and

nuclear plants. Therefore the repair of generating units at these plants is currently receiving utmost attention, especially the quality of the reapirs. Not to hide a sin, it happened sometimes that a supposedly overhauled unit failed after one month of operation. This should be avoided.

"When repairs are completed, including those at the nuclear power plants, the power frequency in the country's power network will be restored."

12973/9835
CSO: 1861/62

EXPERIENCE IN MASTERING GAS-AND-OIL-FIRED BOILERS TGMP-314p WITH BOTTOM ARRANGEMENT OF BURNERS

Moscow ENERGETIK in Russian No 1, Jan 86 pp 8-9

[Article by Engineers R.U. Yusupov, V.A. Kupchenko and A.M. Poslavskiy, Mosenergo - Soyuztekhenergo - Mosenergo TETs-25, under the "Experience in Operating TES [thermal electric plant] Energy Units" rubric]

[Text] A straight-through gas-and-oil-burned boiler TGMP-314p, installed at TETs-25, is the first boiler with super-critical parameters and the bottom arrangement of burners in the Mosenergo system. It was developed on the basis of a serial boiler TGMP-314 and differs mainly in the type and location of burning devices.

In the first phase of the TETs, the design provided for installation of three 250 MW units with TGMP-314ts boilers. The experience in operating these boilers at other Mosenergo TETs demonstrated, that in summer, when there was surplus of gas in TETs fuel balance, it was necessary to constantly burn oil (at least 25% heat-wise) in these boilers, due to design flaws of burning devices, cyclone burners. In the case of prolonged (over 2 weeks) burning of only gas, cyclone lining "wash-out" with burn-off of studs takes place.

A decision had been made to redesign furnace burner devices and to use a bottom arrangement of burners. The engineering project of boiler redesign was developed by the Kharkov branch of TsKB [central design bureau] of Soyuzenergoremont. It provided for installation of eight gas-and-oil-burned burners at the bottom of the furnace. The boiler, station No 3, was rebuilt during installation, with participation of PO [production association] "Krasnyy kotelshchik"; boilers station No 4 and 5 were shipped by the plant with the bottom arrangement of burners already in place.

The capacity of each burner is 9,000 kg/hour with oil, 10,500 nm^3/hour with gas. Burner design is three-furnace, with adjustable degree of air swirling in the peripheral channel (Figure 1). Turn angles of swirler vanes can be changed from 45 to 30°. Design resistance of burners is 2.75 kPa for air and 29.4 kPa for gas.

Recirculation of flue gases is provided in the boiler, and for this purpose, two smoke exhausters DRG-20 were installed; they are made by Mosenergo TsRMZ [central repair and mechanical plant] with maximum utilization of parts and

subassemblies of a mill exhauster fan VM-180/1100. Flue gases are taken for recirculation from the convective shaft behind the water economizer and directed into the hot air duct behind the RVP [not further identified].

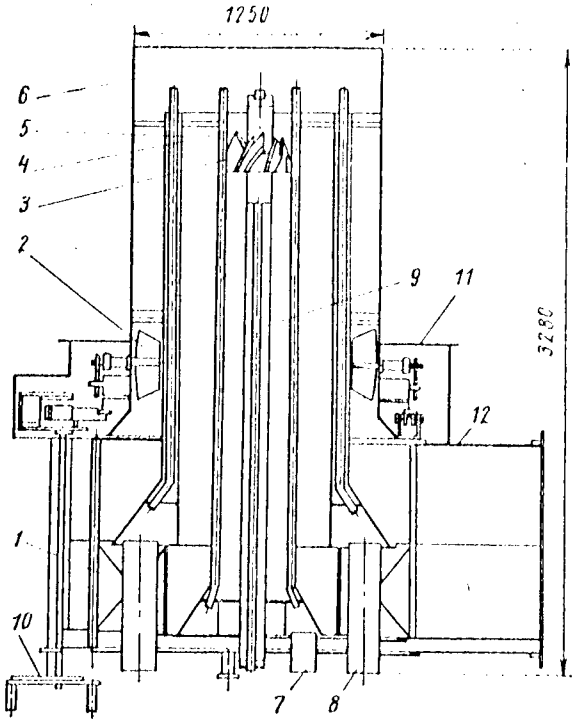

Figure 1. Gas-and-Oil-Burned Bottom Burner

Key:

1. Tangential register
2. Axial swirler
3. Rosette
4. Central air channel
5. Middle air channel
6. Peripheral air channel
7. Central gas chamber
8. Peripheral gas chamber
9. Steam-mechanical atomizer
10. Axial swirler drive
11. Protective enclosure
12. Air duct

In all boilers of this series, temperature control of NRCh [not further identified] metal is organized. At the 13-14 m elevation, eight temperature inserts are installed, four on the front and four on the rear furnace wall. In subsequent boilers of this series, station No 4 and 5, elevation of inserts was determined, based on tests, conducted on the boiler under consideration. On all boilers, an oxygen-neutral water regime is maintained.

Mastering of the TGMP-314p boiler can be conditionally divided into two stages: before and after the redesign. During the initial period of operation, a number of defects were identified, that were decreasing boiler reliability and efficiency. Thus, due to poor choice of the place for installation of the built-in separators subassembly, heat reception in the steam superheater circuit was higher, than recommended, by a factor of 1.5, which caused certain difficulties in maintaining temperature of the atmosphere after the boiler during boiler starts from cold condition.

Due to an error, made at installation, direction of air flow swirling in burners turned out to be opposite to the design (Figure 2). This caused disruption of furnace aerodynamics and erratic flipping of the jet from one furnace wall to another. Jet displacement was due to various factors, the degree of air flow swirling in burners and air flow speed at the exit from the burners being the main ones. It should be noted, that resistance of burners, installed in the boiler, is 1.6 of the design resistance and is equal to 2.75 kPa.

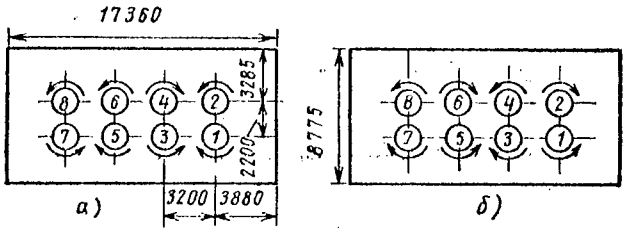

Figure 2. Arrangement of Burners and Configuration of Air Swirling Therein: а) - before the redesign; б) - after the redesign.

A single-row platen steam superheater, that consisted of 20 platens, had a large temperature spread, both along the furnace width and between coils inside a platen. The spread between the platens was equal to up to 20° C, when the boiler operated on gas, and 5-10° C, when it operated on oil; the spread between frontal coils was equal to 60 and 45-50° C, respectively (when calculating from the average temperature of a pair). This corresponded to the following temperature spread ratios: 1.15-1.34 along the gas duct width; 1.6-1.8 along coils inside a platen, versus 1.25, according to the design.

In order to improve reliability, efficiency and starting characteristics, a number of measures were taken during the repair of the boiler:

the platen steam superheater area was reduced from 480 to 405 m^2 by cutting four inside coils out of each platen;

the starting injection subassembly was redesigned;

D-2 design actuator valves were installed in built-in subassemblies;

the design degree of air flow swirling was restored in all burners;

baffles in air ducts in front of burners were removed, which made it possible to reduce air circuit resistance by 0.392 kPa.

These and other measures made it possible to eliminate restrictions as to the boiler load, improve starting characteristics and reliability of the boiler during starts and stability of furnace process in transient modes.

Checking furnace operating modes at various angles of air flow swirling in burners has demonstrated, that the jet position in a furnace does not practically depend on this parameter. When the degree of flow swirling changes from 0 to 30°, the zone of maximum heat release shifts by approximately 1 m, and temperature of gases at the furnace exit decreases by 30-40° C. However, both these modes and modes with negative angles of air flow swirling are characterized by increased consumption of electrical power for blast, due to increased burner resistance. Thus, when the angle changes from 0 to + or - 30°, specific consumption of electrical power for blast increases by 6%.

Adjustment of the air regime of the furnace and burners made it possible to reduce non-uniformities in air distribution between burners down to 5-6%. Critical air excess due to air inflows into the furnace, that increased to up to 7-8%, was equal to 1.05-1.07 (the higher value for oil). The inflows were developing mainly where burners were connected to the furnace bottom. The design of this subassembly does not make it possible to completely eliminate leaks, and it should be redesigned. Under full boiler load on oil, gas recirculation smoke exhausters (DRG) provide a 10% degree of recirculation.

Gross efficiency of the boiler under 90% of nominal load is equal to 92.2% for gas and to 91% for oil, whereas heat losses with effluent gases were equal to 7.5% and 8.7%, respectively. Air inflows in the boiler - smoke exhauster circuit were equal to 42.5%, and specific energy consumption for draft and blast was equal to 4.9 and 5.1 kW-hours per ton of steam for gas and oil, respectively.

These increased heat losses with effluent gases are caused by large inflows into the boiler circuit and by the absence of a portion of RVP packing. After RVP-98 had been redesigned and graphite packings had been installed and after inflows were brought down to the norm, gross efficiency of boilers increased by 1%.

Heat reception of boiler heating surfaces slightly differs from design values. In the case of boiler, operating on gas, and loads, close to nominal, heat reception of NRCh platens is 20 kcal/kg less, than the design value, and is equal to 125 kcal/kg. Heat reception of the rest of furnace platens, including the ceiling and turning gas duct platens, is close to the design values. Heat reception of the steam superheater circuit is higher, than the design value, and is equal to 195 kcal/kg, versus 170 kcal/kg per design. Heat reception of the secondary steam superheater is close to the design value and makes it possible not to turn on the smoke exhausters, when a boiler operates on gas. It is necessary to turn the smoke exhausters on, when a boiler operates on gas, in order to maintain effluent temperature of reheat steam, when the load is equal to or less than 0.7 of the nominal.

When a boiler operates on oil and the degree of recirculation is 5%, heat reception of NRCh is below the design value, and that of platens of the upper furnace portion is slightly higher. Heat reception of the steam superheater circuit is close to the design value.

When a boiler operates on oil, temperature of NRCh metal, measured at the 13-14 m elevation, when the load is close to nominal, is equal to 450-460° C in the case of new (pure) inserts, which corresponds to heat flow rate, equal to 350×10^3 kcal/(m^2 x hour) (407×10^3 W/m^2). When a boiler operates on gas, these quantities are equal to 410° C and 250×10^3 kcal/(m^2 x hour), respectively.

The above heat flow rates are considerably lower, than in a boiler with cyclon burners, where feed flows equalled approximately 600×10^3 kcal/(m^2 x hour).

Tests, performed on the boiler, revealed a peculiar instability of aerodynamics of the furnace with the bottom arrangement of burners. Boiler operation was least stable, when air flow in burners was swirled in the direction, opposite to the design. During this period, jet flippings from one furnace wall to another were observed. In order to eliminate temperature stratification, one had to bring the difference in water consumption in lines to 40-60 tons per hour. Jet position was least stable in the case of large angles of air flow swirling.

After the direction of swirling had been restored, jet flippings stopped, jet position in the furnace stabilized, and change in the degree of swirling of air flow in burners did not cause considerable temperature stratification along the boiler circuit; in this case, the maximum heat release zone in the absence of swirling was located in the zone of 13-15 m elevations.

Observations of NRCh metal temperature, that have been conducted on all boilers from the moment of commissioning thereof, demonstrate, that up until now, these temperatures do not exceed 480° C. Comparative analysis of the efficiency of various modifications of TGMP-314 boilers, installed at Mosenergo power plants, demonstrates, that boilers with the bottom and the regular cross arrangement of burners are about equivalent, but the bottom arrangement of burners has a number of advantages over cyclon burners.

Conclusions

1. Sufficiently long operation of the boiler has demonstrated the correctness of basic technical solutions, made during its design and redesign.

2. The bottom arrangement of burners makes it possible to create an elongated zone of maximum heat release and to decrease received heat flows in the zone of NRCh platens.

3. Boiler efficiency is close to that of TGMP-314 boilers with the wall arrangement of burners, provided the gas circuit is sealed and the design RVP packing is used.

4. In order to improve lighting-up characteristics of the boiler, the built-in separators subassembly should be relocated closer to the platen steam superheater.

5. In order to reduce inflows, the burners connection to the furnace bottom subassembly should be redesigned.

12770
CSO: 1861/253

UDC 627.845

PROGRAMMED CLOSURE OF GATES BY PUMPING UNIT UPON DRIVE FAILURE

Moscow GIDROTEKHNICHESKOYE STROITELSTVO in Russian No 7, Jul 86

[Article by V.Ya. Karelin, doctor of technical sciences, N.N. Arshenevskiy, R.A. Novoderezhkin, B.B. Pospelov, candidates of technical sciences, and V.N. Zakharov and P.P. Chirkov, engineers]

[Abstract] In pumping stations with back valves, delays in gate closure cause dangerous hydraulic shocks. In stations without back valves, slow closure of valves or gates causes water leakage from the delivery pipe and resultant reverse rotation and high dynamic loading in case of drive failures. Computer calculations of the process of pump drive failure, using a program based on simultaneous solution of the equations of rotation of the rotor unit and the hydraulic head equations, considering the elasticity of the water and of the pipe walls, were used to seek an optimal rule for gate closure. The results of the calculation indicated that the program for closure of a disk gate must satisfy the requirement of minimum increases in pressure in case of loss of power to one unit only. A joint graph of the change in pressure under both conditions was constructed for a station with three pumps. An example is presented of determining the required closure at a pumping station with pumps working in pairs into a common delivery pipe. Figures 4.

6508/9835
CSO: 1861/16

UDC 621.311.161:658.514.011.56

SITUATION TRAINING DEVICE FOR DISPATCHERS AT ODU SIBERIA

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 86 pp 8-9

[Article by V.V. Shurupov, engineer, ODU Siberia]

[Abstract] Dispatchers at ODU [Branch Supervisory Control of the Integrated Power System] Siberia are being taught on a training device built in 1974 about how to prevent and clear faults within a power grid. A set of programs was written by this author in 1984 called TRENAZHER, for computer-aided fault simulation and display by the trainer on the instrument panel. The information for the trainee to act upon includes intersystem power transfers, frequency in each power system, load on each hydroelectric power plant, state of the automatic frequency and power regulation system, and the time. The trainer sets up fault conditions indicated by instruments according to TRENAZHER. The trainer can increase or decrease the power demand or power supply at various points at any given time, connect or disconnect individual lines or entire circuits, synchronize separately operating grid segments, and vary the maximum permissible circulating current in a way which simulates automatic cutoff of asynchronous operation. The training program fits the structure of the Siberian power grid, reduced to 46 nodal points and 60 connecting lines. It is sufficiently flexible for corrections and improvements as well as for modifications to suit integrated dispatch control in other regions. It is designed for computers of YeS-1030 or better class and YeS-7920 displays.

2415/9835
CSO: 1861/53

UDC (658.512.4:629.12)(47+57)

INTEGRATED PREPARATION OF PRODUCTION IN SHIPBUILDING ENTERPRISE FOR ACCELERATION OF SCIENTIFIC-TECHNICAL PROGRESS

Leningrad SUDOSTROYENIYE in Russian No 7, Jul 86 pp 32-35

[Article by A.R. Aryu]

[Abstract] A computer-aided design system for integrated process planning of construction is proposed and outlined which should ensure that shipbuilding enterprises will meet quotas during the 1986-90 period and beyond until the year 2000, in step with accelerating scientific-technical progress as well as with growing socio-economic demands. The system covers five basic components of the shipyard preparation process, namely engineering and manufacturing documentation based on ship design analysis, shipyard facilities documentation, organizational and routing documentation, engineering standards documentation, and a log of standardized preparatory operations. The computer program is constructed so as to yield a sequence of procedures which will correspond to delivery schedules, up to and including the first ship of a new design. It incorporates corrective design on each step for optimization, namely for reconciling any conflict between engineering, planning, and construction goals. Technological preparation is the most time and labor consuming phase of the process, this being reflected in the structure of the computer-aided design system. Figures 4; references 1: Russian.

2415/9835
CSO: 1861/48

INTENSIFICATION - IMPORTANT PROBLEM FOR SHIPBUILDING INDUSTRY

Leningrad SUDOSTROYENIYE in Russian No 7, Jul 86 pp 35-36

[Article by A.N. Khaustov]

[Abstract] The problem of intensifying development and production, for the benefit of the Soviet people, is also faced by the shipbuilding industry. Goals of the "Intensifikatsiya-90" program for the 12th Five-Year Plan period include implementation of scientific-technical progress in the shipyards, with emphasis on laser technology, computer-aided flexible production and process automation, also on maximum equipment utilization, better labor and talent management, and maximum economy of resources such as energy and metals. Principal enterprises participating in this program are the Baltic shipyard imeni Sergo Ordzhonikidze, the Leningrad shipyard imeni A.A. Zhdanov, the "Baltiya" shipyard, the Black Sea shipyard, the "Krasnoye Sormovo" shipyard imeni A.A. Zhdanov, and the Leningrad Admiralty Association, with various collectives and regional enterprises assisting. The program is designed in accordance with the general socialist principle of supplying goods to meet the consumer demand.

2415/9835
CSO: 1861/48

HUMAN FACTORS IN ROBOTIC SYSTEM DESIGN DISCUSSED

Moscow IZVESTIYA VYSSHYKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 8, Aug 86 pp 76-78

[Article by Professor V. N. Prokofyev, Doctor of Technical Sciences, and T. A. Chernysheva, graduate student: "The Human Factors Problem in Robotic System Design"]

[Text] The present study discusses a principle underlying the investigation of a manipulation robot with hydraulic drive remotely controlled in a semiautomatic mode. The authors present experimental data on the operation of the hydraulic drive of the manipulator obtained by the frozen coefficient method. They obtain parameters at which the system is stable. Results are presented of an investigation of the man-operator-hydraulic drive system with tracking (accomplishing the operation of gripping a floating object) at a frequency of 0.1 Hz.

The intensification of industrial production, efforts to move in the direction of the exploitation of space and work at great depths in the world's oceans, where it is not possible to put forward an algorithm for an automatically functioning system ahead of time have created the need to develop robotic systems which can be controlled by a human operator remotely. There are a variety of ways by which these systems can be controlled. Let us look here at a semiautomatic control system, in which the motion of a control is proportional to the motion of the actuating drive of the manipulator. The controlled object is an electrohydraulic throttling drive, which is used in manipulators under conditions which require the development of considerable force, under water, for example, where they might be used to cut metal, weld, assemble, tighten and loosen nuts, drill holes, bore into hard, rocky earth and lift and move loads under water.

The parameters of the electrohydraulic drive here are going to be the sole determinants of the efficiency of the system overall, so the objective of our investigation was to arrive at a set of parameters for the electrohydraulic drive of a manipulator designed to be controlled remotely by a human operator and then to compare these parameters with those for the same drive system operated automatically. This kind of comparison is essential to any analysis of the quality with which the system functions in each instance. The results of this analysis enable us to answer the question of the advantage to be derived from taking account of the "human factor" in determining the parameters of an object in the design stage.

The parameters of an object to be controlled by a human operator remotely will be based on the criteria defining the function of the system. The entire range of the functions a manipulator will perform can be reduced to two: to move the end of the manipulator along a specified trajectory with desired precision and then to perform the desired operation (grasp an object, drill a hole, tighten a nut etc.). As far as the semiautomatic mode is concerned, the most important thing is for the end of the manipulator to be guided accurately to the object to be controlled or manipulated, so we should focus our attention here on the process involved in providing the manipulator with guidance of the desired degree of precision. This process is governed by the dynamic parameters of the hydraulic drive for both the automatic and semiautomatic modes. With its parameters varied, the performance criterion of the system is going to be the integral error in the tracking of the operator or the integral error in the hardware when it functions without the involvement of a human operator. To evaluate the controlled object we employed the following performance criterion, which defines the precision of the guidance:

$$J = \frac{1}{T}\int_0^T |\varepsilon(t)|\,dt, \tag{1}$$

where T is the time of integration, ε the error between the input and output signals.

According to (1), the controlled object will be described by a transfer function of the type

$$W(S) = \frac{K_{obshch}}{S(T_y S + 1)(T_{egu} S + 1)(T_{dv}^2 S^2 + 2\xi T_{dv} S + 1)}, \tag{2}$$

where K_{obshch} is the system gain factor, T_y the time constant of the electronic amplifier, T_{egu} the time constant of the electrohydraulic amplifier, T_{dv} the time constant of the hydraulic motor and ζ the damping coefficient for the system. When we link up the feedback system we then have to take account of the feedback factor K_{oc} as well [2].

We find the parameters of the controlled object in the system in which a human operator does not participate in the traditional way. Before we move on to look at the control of a semiautomatic system, let us note that we base our selection of the parameters of the electrohydraulic drive in this case on the results of an experimental procedure, what with the fact that a theory governing the computation and design of a man-machine system has yet to be elaborated. The special nature of the control function in a semiautomatic system consists in the fact that the quality with which the system functions is also going to depend on the psychopsysiological capacities of the human operator. In other words, we have to establish the price at which achieve the quality we desire. The "cost of performance" is expressed as the level of psychopsysiological stress on the human operator as recorded as he controls a dynamic object. In accordance with (3) we compute this psychopsysiological stress as follows:

$$H = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\frac{|X_i - X_i^{\Phi}|}{|X_i^{max} - X_i^{\Phi}|}}, \tag{3}$$

where H is the stress factor, X_i the mean value per minute of the i-th psychophysiological indicator, X_i^{max} the maximum possible value of the i-th indicator, X_i^f the background value of the i-th indicator and n the number of indicators used.

In our tests we recorded the respiratory rate, the frequency of the heart contractions and the galvanic skin response. Our half-scale model consisted of a controlled object in the form of a model on the AVM DO-720, a control lever and a system enabling us to display information for the human operator (Figure 1).

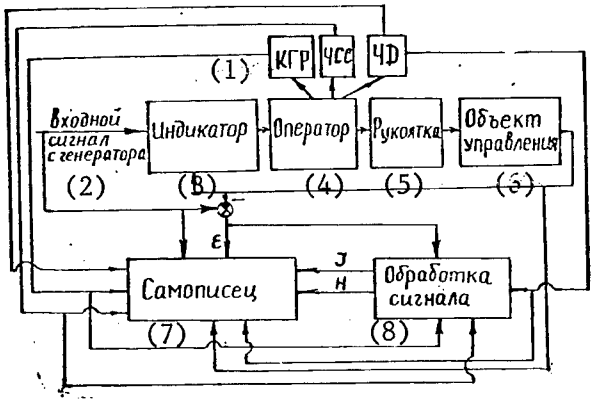

Figure 1

Figure 1. (1) - galvanic skin response, rate of heart contraction, respiratory rate; (2) - input signal from generator; (3) - indicator; 4 - operator; 5 - control; 6 - controlled object; 7 - automatic recorder; 8 - signal processing

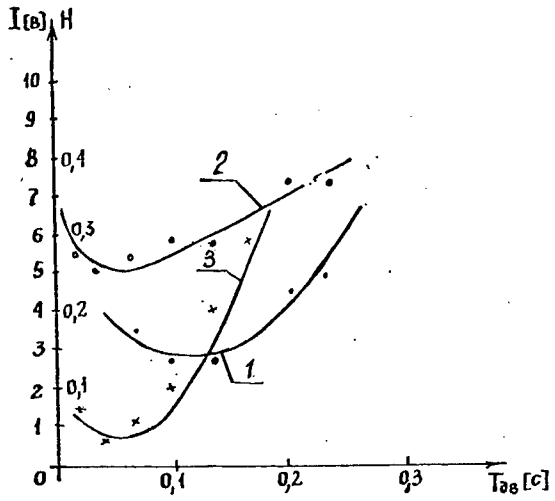

Figure 2

By way of example, Figure 2 plots values for the integral quality factor for a system J for a given controlled object without, Curve 1, and with, Curve 2, a human operator in the control loop and an operator stress factor H, Curve 3, as a function of a constant time value T_{dv}. From the data shown here it can be seen that the parameters for a hydraulic drive system established on the basis of a minimum integral error, taking account of the psychophysiological performance cost, do not by any means coincide with those found by the traditional method for an automatic system.

We can therefore see that parameters obtained for an automatic system cannot be used in the design of a system in which a human operator is going to participate in the control loop.

These results point to the need to take the "human factor" into account, a factor expressed in terms of the psychophysiological cost which the operator "bears" in the process of controlling an object with variable dynamic parameters.

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8963
CSO: 1861/30

UDC 621.833.15.002.645:621.794.004.67

IMPROVING REPAIRABILITY OF GEARS

Moscow MASHINOSTROITEL in Russian No 5, May 86 p 34

[Article by Candidate of Technical Sciences S.A. Belyayev]

[Text] Increased service life and decreased vibrational activity of gear transmissions can be achieved by using composite gears (CG) with self-aligning ring gears. In such gears, power interaction between the ring gear and the hub is accomplished via elastic joints. In repairing a CG, the most acceptable solution is to replace a worn ring gear with a new one, while reusing the hub over and over again. However, existing methods for repairing CG, that are in the first place determined by methods of realizing elastic joints between ring gears and hubs, are characterized by extremely high labor content and sometimes make the feasibility of using CG in the national economy questionable.

In order to improve CG repairability, an intermediate ring is placed between the ring gear and the hub. Elastic joint elements or special seats for securing thereof are made on the intermediate ring surface, mating the hub. In this case, the hub and the intermediate ring assembly, together with their elastic joint elements, constitute an elastic-pliable block, that is repeatedly reused, when a CG is repaired. Change ring gears are smooth-bored. Assembling them with the elastic-pliable block is extremely simple and is performed by press fit or by using an adhesive composition. As a result, the labor content of assembling and disassembling, when worn ring gears are replaced with new ones, is considerably lower.

The design of such gear (USSR Certificate of Authorship No. 696225) is shown in the Figure above. Ring gear 1 and hub 2 have semi-round holes, made after the assembly. In the holes, twisted rollers 3 are installed. Between the ring gear and the hub, clearance is provided, that facilitates self-alignment of the ring gear, when it is engaged with the mating gear, and eliminates direct contact with the hub. Ring gear 1 and elastic elements 3 are fixed in the axial direction by means of face plates 4. In CG design, intermediate ring 5 is used. In large diameter gears, as well as in switchable ones, that also wear extensively at the mounting bore, it is probably feasible to use second ring 6, connected with the hub by means of a press fit or an adhesive. Technological holes 7 are intended for fasteners, that prevent

the shift between the ring gear and the hub, machined together; after the machining, the fasteners are removed.

When a regular design CG is repaired, operations of special machining of the mating surface of a spare ring gear are repeated (see Table). In this case, the required accuracy of ring gears can only be ensured, if they are assembled with hubs, which in turn calls for periodic return of worn CG to the manufacturer.

Compared to the process of manufacturing a regular gear, the process of manufacturing an improved CG includes additional operations of manufacturing an intermediate ring and press-fitting a ring gear onto an elastic-pliable block. However, CG repair takes less time and only includes the operation of press-fitting a new ring gear instead of the worn one, and this operation can be successfully performed by the customer after receiving spare ring gears from the manufacturer. In this case, the possibility is created to standardize elastic-pliable blocks in accordance with standard gear sizes; interchangeability of change ring gears is also achieved, which facilitates popularization and wider application of CG in machine building industry.

Operation	Regular CG		Improved CG		Operation	Regular CG		Improved CG	
	Mfg	Repair	Mfg	Repair		Mfg	Repair	Mfg	Repair
Take off face plates		+			Secure intermediate ring on hub			+	
Take off worn ring gear		+		+	Machine holes for elastic elements	+	+	+	
Make new ring gear	+	+	+	+	Take ring gear off hub	+	+		
Make intermediate ring			+						
Press fit ring gear onto hub	+	+			Take intermediate ring off hub		+		
Press fit intermed-iate ring onto hub			+		Weakening of joint by boring ring gear	+	+		
Secure ring gear on hub	+	+			Install ring gear and other elements	+	+		

(Table continued on following page)

Operation	Regular CG		Improved CG		Operation	Regular CG		Improved CG	
	Mfg	Repair	Mfg	Repair		Mfg	Repair	Mfg	Repair
Install intermediate ring and elastic elements			+		Press fit ring gear onto intermediate ring			+	
Install face plates	+	+	+						

12770
CSO: 1861/495

UDC 621.865.8:621.73

DESIGNS AND USE OF SUSPENDED MANIPULATORS IN FORGING-STAMPING PRODUCTION

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 9, Sep 86 pp 33-35

[Article by A. A Kolupayev, F. S. Kokin, N. I. Osipov and M. L. Stashenko]

[Text] Analysis of Soviet and foreign designs of floor rail-mounted, railless and stationary suspended manipulators showed that the use of suspended forging-stamping manipulators is most feasible for mechanization and automation of fabrication of forgings and stamped blanks weighing from 20 to 500 kg. There is also a trend in use of suspended designs for transport, machine-tool and loading-unloading manipulators.

This is explained by the fact that the assemblies of a manipulator, having larger overall dimensions (housing, drives, traveling part and rail tracks), are located on top. Only the working members with clamping devices are located below, directly in the working zone. Moreover, a large number of production machines, located on a large production area, can be serviced by a single manipulator.

Due to the production conditions of forging and stamping, the blacksmith, when using manipulators, must constantly correct and change the relative orientation of gripper and forging, remove the scale, take measurements and perform other operations. Therefore, due to safety conditions, the suspended manipulator should satisfy the following basic requirements: the width of the part of the manipulator approaching the blacksmith from behind should not be greater than the diameter of the circumference of rotation of the tongs; the tong end-effector (gripper) should have no other protruding parts except the tong levers; the peripheral speed of the end effector with respect to the vertical axis (rotation of the column), measured in the horizontal plane at the ends of the levers, and the speed of lateral motion should not exceed 60 m/min.

A number of designs of suspended forging-stamping manipulators with capacity of 100-500 kg, designed for operation under different conditions of existing plants, was developed at the Ustinovka Mechanics Insititute with regard to the indicated requirements and the general requirements of safety on forging operations and equipment, stacking cranes and industrial robots according to GOST [State Standard] 12.3.026-81, GOST 12.2.017-78, GOST 12.2.053-81 and GOST 12.2.072-82. The need for these machines, estimated according to the installed forging equipment and requests of enterprises and organizations, is high.

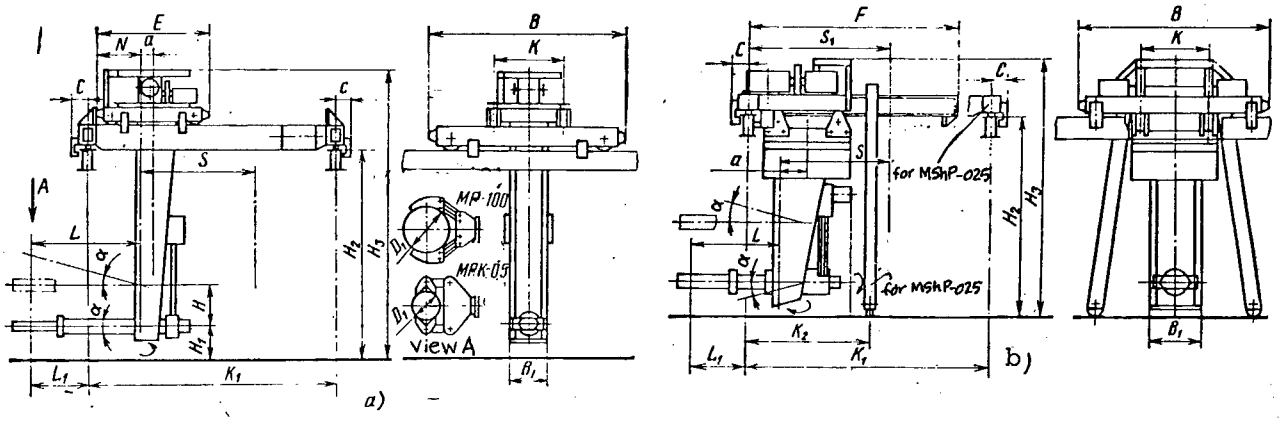


Figure 1. Overall View of Suspended Manipulators: MPK-0.5, MP-100 (a) and MSh-025, MShP-025 (b)

The reference design of suspended manipulators is a bridge, resting on support beams 3-3.5 m high. A support or suspended trolley, to which is attached a rigid load-bearing column, is installed on the bridge. The column can be fixed or rotating and mounted on the trolley by means of a roller support-rotating device. The yoke of the manipulator with axial and vertical shock absorbers, which protect the manipulator against dynamic loads during forging and transport, is mounted in the bottom part of the column. The design of the yoke suspension provides for planoparallel movement of the yoke by the extent of deformation of the blank during forging and by its inclination upwards and downwards. An electromechanical drive is used for parallel hoisting of the yoke.

A blank in the gripper is clamped by a hydraulic cylinder, which is powered from a hydroelectric station with control equipment located on the load-bearing column. The hydraulic drive is also used to relieve the yoke of the tipping moment, inclination of it and rotation of the gripper.

An electromechanical drive with chain transmission from a reduction gear to the trolley is used to move the trolley along the bridge. This permits rigid connection of the trolley to the bridge, which is necessary for automation of forging and stamping processes. The bridge is moved along the support beams by an electromechanical crane drive using drive running wheels or rack-and-gear drive. The bridge can rest by one side on the support beam, installed upon one row of columns, and by the othe side through the supports with rollers on a rail, located on the floor of the section. This version makes it possible to install the manipulator in existing stamping sections, for example, for mechanization of swage hammers with maxium force of 10, 16 and 25 tons, without large expenditures.

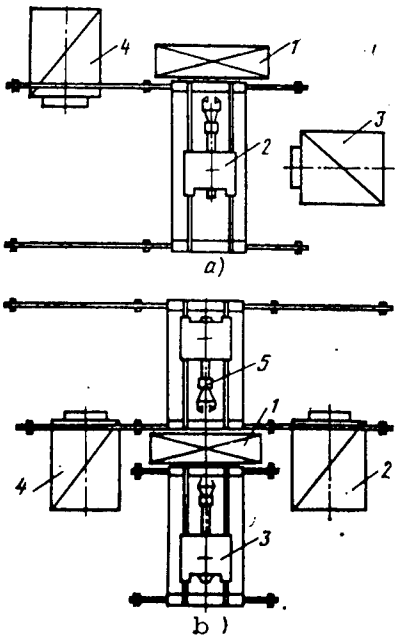


Figure 2. Layout of Forging Sections: a--with one manipulator (1--swaging with maximum force of 2 tons; 2--MPK-05 manipulator; 3, 4--heating furnaces); b--with two manipulators (1--swage hammer with maximum force of 3 tons; 2,4--heating furnaces; 3, 5--MPK-0.5 manipulators)

The manipulator is controlled remotely by hand from the stationary control console, located near the forging unit with regard to a convenient view of the work zone. The main production motions of the manipulator--raising and lowering the yoke, rotation of the gripper and movement of the trolley and bridge--are provided by manipulation by one control lever, rotated in the same direction as the operating mechanisms of the manipulators. If there is no place to locate the stationary console, a console installed on a column can be used in some models or a control cab, attached to the support frame of the bridge and rollers, can be installed.

The rotation operations of transporting the blank from the heating furnace to the forging unit and return of the manipulator from the unit back to the furnace can be semi-automated for forging and stamping sections with serial production of forgings. This is provided by introducing UTsM-663 or UTsM-100 cyclic program control devices and a set of position sensors on the mechanisms for moving the bridge, trolley and for raising the yoke in the manipulator control system. The electrical equipment, located on the movable mechanisms of the manipulator, is connected to the stationary cabinets of the control system by a special rotary and linear multiwire conductors.

An overall view of suspended manipulators is shown in Figure 1.

Main Structural Dimensions of Manipulators

	MSh-025	MShP-025	MPK-05	MP-100
Greatest height from floor level H_3, mm	4,800	4,800	4,350	4,460
Height of support beams H_2, mm	3,000	3,000	2,950	2,950
Greatest distance from yoke axis to floor H_1, mm	600	600	550	480
Height of raising yoke H, mm	1,050	1,050	500	1,400
Span of bridge K_1, mm	--	4,500 5,000	5,000 5,400 6,000 6,500	4,500
Distance between support beam and support K_2, mm	2,800	--	--	--
Gauge of manipulator trolley K, mm	900	900	1,400	1,400
Width, mm:				
of manipulator bridge B	2,790	2,790	3,650	3,650
of manipulator column B_1	760	760	580	595
Overhang of manipulator yoke L, mm	1,800	1,800	1,520	2,800
Overhang of yoke with respect to support columns L_1, mm	1,450	1,450	900	2,190
Travel of manipulator trolley S, mm	2,500	2,500- 3,000	3,000- 4,500	2,840
Maximum distance from column axis to support beam S_1, mm	3,200	3,200- 3,700	3,515- 5,015	3,550
Distance from outer points of bridge to axis of support beams C, mm	246	246	175	175
Length of trolley E, mm	1,305	1,305	1,895	1,526
Distance, mm:				
from trolley axis to column axis a	150	150	250	170
from column axis to edge of trolley N	500	500	515	593

(Table continued on following page)

Diameters of blanks to be gripped D_1, mm	20-250	20-250	80-500	400-1,250
Angle of inclination of yoke α, deg	+5 to -15	+5 to -15	± 15	--
Length of main beams F, mm	4,770	--	--	--

Main Specifications of Manipulators

	MSh-025	MShP-025	MPK-05	MP-100
Rated capacity, kg	250	250	500	100
Greatest load moment kN·m	1.0	1.0	6.0	--
Number of degrees of mobility	5	6	6	4
Type of drives:				
for moving bridge	EM	EM	EM	EM
for moving trolley	EM	EM	EM	EM
for rotation of column	EM	EM	EM	EM
for rotation of tongs	H	H	EM	--
for raising yoke	EM	EM	EM	EM
for inclination of yoke	H	H	H	--
for clamping tongs	H	H	H	Pn
for regulation of tongs	--	--	--	EM
Control unit	cyclic	cyclic	--	cyclic
Number of programmable coordinates	4	4	--	4
Positioning error, mm	±5	±5	--	±5
Weight, kg:				
of manipulator (suspension part)	1,800	1,950	3,600	2,170
of bridge	1,750	2,650	3,870	3,230
total (with electric equipment)	3,850	4,900	7,770	5,700
Linear displacements:				
greatest travel of bridge, mm	25	25	25	25
travel of trolley, m	2.5	2.5-3.0	3.0-4.5	2.84
raising of yoke, mm	1,050	1,050	500	1,400
greatest opening of tongs, mm	250	250	500	1,250
Angular displacements, degrees:				
rotation of column	--	270	270	240
inclination of yoke	+5 to -15	+5 to -15	±15	--
rotation of tongs	270	270	360.P	--

(Table continued on following page)

Speed of linear displacements, m/s:				
of bridge	0.2-1.0	0.2-1.0	0.3-0.67	0.2-1.0
of trolley	0.3-0.5	0.3-0.5	0.15-0.3	0.1-0.5
of rise of yoke	0.1-0.25	0.1-0.25	0.1	0.1-0.25
Rate of angular displacements, degree/s:				
of rotation of column	--	90	30	30
of inclination of yoke	5	5	5	--
of rotation of tongs	180	180	180	--

Note. EM--electromechanical drive; H-hydraulic; Pn-pneumatic drive.

The main structural dimensions and specifications were established with regard to the production features of forging and stamping and GOST 17808-82 and GOST 25378-82.

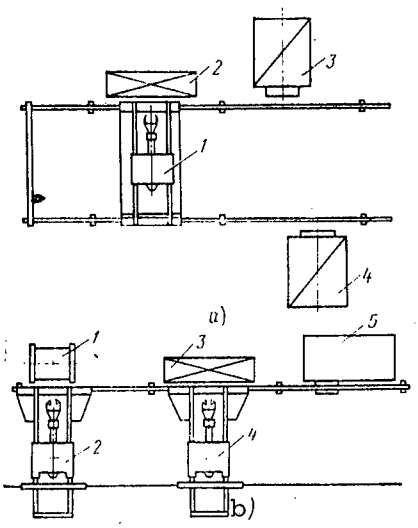


Figure 3. Layout of Sections: a--sheet-metal stamping (1--MP-100 manipulator; 2--press with force of 3.15 MN; 3, 4--heating furnaces); b--hot stamping (1--cutoff press; 2, 4--MSh-025 manipulators; 3--swage hammer with maximum force of 16 t; 5--semi-holding furnace)

Suspended manipulators can be used in forging complexes based on steam-air hammers with maximum force of 2, 3 and 5 tons, forging presses with force of 3 and 5 MN and in stamping complexes with hammers having maximum force of 10-25 t or with extensible presses with force of 20 and 40 MN. When arranging the equipment, the designs of suspended manipulators and their basic motions are taken into account. Two manipulators can be used if it is necessary to regrab the blanks for delivery of the tool when forging long forgings and also for transfer of the blanks to subsequent transitions. Standard layouts of the equipment in the production sections of several enterprises that use suspended forging-stamping manipulators are shown in figures 2 and 3.

Standard crane mechanisms and special mechanisms that prevent bending the blanks during forging and that protect the manipulators against dynamic loads are used in the manipulator design.

The cost of a MPK-0.5 manipulator, manufactured at the Izhtyazhbummash Plant, with three thyristor control stations comprises 29,000 rubles. Labor productivity is increased by 20-60 percent when using the manipulators and the saving is 12,000-35,000 rubles as a function of the list of forgings and stamped blanks. The calculated reliability indicators of the manipulators for the makeup articles used in the design comprise: mean time between failures of 200 hr, average service life to major overall with two-shift operation--five years and service life to removal from service--15 years.

Thus, the developed designs of suspended manipulators can be used for mechanization and automation of newly designed and existing forging and stamping sections for producing blanks weighing 20-500 kg.

6521
CSO: 1861/63

PROCEEDINGS OF CONFERENCE ON VIBRODIAGNOSTICS DISCUSSED

Moscow MASHINOVEDENIYE in Russian No 4, Jul-Aug 86, pp 103-104

[Article: "The First All-Union Conference on Problems in Vibrodiagnostics for Machines and Instruments"

[Text] An important role in the effort to accelerate our advancement in science and technology falls to work in the field of mechanical diagnostics for machines and mechanical devices generally, structures and structural components and intruments. Mechanical diagnostics permits solution of problems such as those of locating malfunctions without having to disassemble a stucture or a piece of equipment and establishing the true condition of an object, which makes it possible to avoid highly ineffective scheduled preventive maintenance. Mechanical diagnostics permits optimum regulation of machinery and equipment, forecast operating conditions and prevent the development of problem situations. Mechanical diagnostic systems are highly effective. Calculations show that for every ruble invested in the development of mechanical diagnostic systems there is reason enough to anticipate a return of ten.

Despite this, however, the organization of efforts in the field of mechanical diagnostics is still leaving a great deal to be desired. The basic shortcomings consist in the fact that these efforts are not coordinated. There is no single national program to set guidelines. There are no primary organizations responsible for the development of mechanical diagnostic systems. Finally, there are problems with the development and production of measuring and analytical apparatus.

Vibroacoustic diagnosis for machines and equipment is one of the most important areas in the field of mechanical diagnostics. Machines in operation generate vibroacoustic signals, the parameters of which contain information defining the operating condition of the piece of machinery or equipment involved. To one degree or another, work in the field of vibroacoustic diagnostics is coordinated by the Vibroacoustic Diagnostics Section of the USSR State Committee on Science and Technology's Scientific Council on Vibration Protection for Machines and Vibration Technology. Beginning in 1983, the section has held conferences and seminars to discuss work in progress in the field vibroacoustic diagnostics for machines, equipment and structures. Seminars have been held in Moscow, Riga, Gorkiy, Kaunas and Zaporozhye.

From September 9-11, 1985, the Ivanovo Institute of Power Engineering (Department of Theoretical and Applied Mechanics) in Ivanova hosted the 1st All-Union Conference on Problems in Vibroacoustic Diagnostics for Machines and Equipment. The organizing

committee for the conference was chaired by Academician K. V. Frolov, vice-president of the USSR Academy of Sciences. In a letter of greeting he underlined the importance of continuing efforts in the field of vibroacoustic diagnostics, which he referred to as one of the most critical directions for accelerating the pace of scientific and technological advancement in the machine-building and instrument-making industries. The same session also heard reports by Prof. M. D. Genkin, deputy chairman of the scientific council, Prof. A. L. Gorelik, chairman of the section, Prof. S. S. Korablev (Ivanovo Institute of Power Engineering), Prof. Ye. G. Nakhapetyan (Institute of Machine Science [IMASh], USSR Academy of Sciences), Prof. Yu. Zakoryukin and V. A. Klochko, Candidate of Technical Sciences.

M. D. Genkin's report on scientific advances at the USSR Academy of Science's Institute of Machine Science imeni A. A. Blagonravov in the field of the methodology associated with vibroacoustic diagnostics as applied to machines and mechanical devices led to the proposal to set up a national Scientific Center for Vibroacoustic Machine Diagnostics, which would be operated by the institute and number of participating branch organizations and given the responsibility of coordinating work and providing the scientific direction in the effort to develop methods and equipment for diagnosing the operating condition of mechanical systems. In his presentation, A. L. Gorelik formulated the basic tasks in both the theoretical and applied areas which should be the focus of efforts to advance the field of vibroacoustic diagnostics.

Yu. V. Zakoryukin discussed the history, traditions, scientific efforts and training program of the Ivanovo Institute of Power Engineering. S. S. Korablev presented a paper outlining the scientific research and developments in the applied area under way at the institute in the field of mechanical system oscillations.

The conference worked in two sections: "Vibrodiagnostics for machines and mechanical systems" and "Vibrodiagnostics for structures and structural components." Taking part in the work of these sections were representatives of the following scientific centers: Moscow - 38 papers, Leningrad 36, Kiev 9, Kaunas 6, Riga 5, Sverdlovsk 3, Omsk 6 and Yerevan 5, 37 cities in the country being represented overall. Participating in the work of the conference were 215 of the country's leading experts.

The importance of this conference can be gauged from the fact that it proved an occasion for an exceptionally productive exchange of experience in the theoretical study and development, introduction and practical application of vibroacoustic diagnostic systems and equipment in a number of fields of engineering. All papers and reports heard delivered at the conference focused on subjects relevant to current interests: the theoretical and practical aspects of the development of mini- and microcomputer-based vibroacoustic diagnostic systems as well as systems incorporating the high-capacity computers, development of experimental methods and means of automating vibration tests and the modeling of vibroacoustic processes in machines, equipment and structures.

A number of papers and the discussions which followed drew particular attention to some serious shortcomings in the field hydroacoustic diagnostics, situations which are placing obstacles in the way of any extensive introduction of these systems into practical use within the national economy. Among the most critical problems are the extremely limited volume of vibration measuring and analyzing apparatus we are making and the failure to provide specialized training for scientists and engineers working

in the field. The country's institutions of higher education do not have mechanical diagnostics departments, offer no academic specialization in this field and no research laboratory set up to focus on the problems in this area. With the objective of remedying these shortcomings, the conference adopted a resolution containing a number of recommendations to be submitted to the Ministry of Higher and Secondary Specialized Education, the Ministry of Instrument Making, Automation Equipment and Control Systems, the Ministry of the Radio Industry and a number of other ministries. Implementation of these recommendations would be to the substantial benefit of the national economy.

8963
CSO: 1861/39

UDC 621.865.8.001.5

DETERMINATION OF NOMINAL DESIGN LOADING OF MANIPULATOR SYSTEMS OF INDUSTRIAL ROBOTS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 86 (manuscript received 8 Oct 85) pp 48-52

[Article by A.N. Makarov, lecturer and candidate of technical sciences]

[Abstract] Strength and stiffness design calculations are done for an industrial robot manipulator based on an analysis of the manipulator as a system with a variable configuration of linkages and forces. The objective function in the nonlinear programming analysis is the square of the equivalent stresses for one of the strength hypotheses, which are the integral characteristic of the stressed state at a specified cross-section. The determination of the design loading reduces to the determination of the maximum of the stressed state characteristic function, given the condition that the arguments of the function and the coordinates of the external load application points on the linkages are subject to equality-type constraints that follow from the continuity condition for the kinematic chain of the manipulator (a typical nonlinear programming problem). The proposed method reduces to the problem of worst case design and makes it possible to approach the strength and stiffness calculations of the structural members of manipulators in a deterministic formulation. The theoretical treatment adduces neither numerical examples nor sample designs. Figures 2; references 2: Russian.

8225/9835
CSO: 1861/374

UDC 534.833.532.22

AERODYNAMIC NOISE REDUCTION BY MEANS OF COMBINATION-TYPE SILENCERS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 3, Mar 86 (manuscript received 2 Sep 85) pp 37-40

[Article by A.S. Terekhin, Senior Lecturer, candidate of technical sciences and V.I. Yakhontov, junior lecturer]

[Abstract] The absorption-type noise suppressors usually employed in the metallurgical industry to silence aerodynamic noise from air intake or distribution equipment, gas jets, and various types of fans are efficient only at intermediate and high audio frequencies. The reactive resonant silencers used to suppress discrete low frequency components work well at the resonant frequency, but not at others. This paper analyzes the design of a new combination-type noise suppressor combining the best properties of the previous designs. Noise suppression in a typical application using the new two element silencer is graphed showing the noise in dB with and without the suppressor at frequencies from 63 to 8,000 Hz. The new design provides an average broadband reduction of about 20 dB over this frequency range with a maximum noise reduction of 25 dB (115 to 90 dB) at 125 Hz. Analytical expressions are given for determining the noise reduction of the individual resonators and their combination. Figures 3; references 4: Russian.

8225/9835
CSO: 1861/340

UDC 629.7.08

ENHANCING EFFICIENCY OF DRYING PROCESS BY MEANS OF COOLING IN TUBULAR FINNED AIR COOLERS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 3, Mar 86 (manuscript received 4 Jul 85) pp 74-78

[Article by V.A. Kanavo and A.A. Polyakov, candidates of technical sciences]

[Abstract] Frost formation changes the heat and mass exchange process in an air cooler and dryer, necessitating process testing of air coolers of various designs for which standards have not been developed in order to precisely determine system performance. This paper describes the design and operation of a system for testing air coolers in the presence of moisture condensation and frost formation. The test stand can analyze the operation of various direct air coolers as well as systems using an intermediate coolant, and maintain the air temperature and humidity at the inlet to the cooler under test at dew points down to 243 K and moisture

contents of 0.5 to 10 g/kg. The test stand measure air moisture content with the "Volna IM" and "Baykal" instruments and a dew point hygrometers. Fog formation is monitored by a laser system while coolant flow rates are determined with a "Turbokvant" mass rate of flow turbine sensor. Performance parameters of finned and tubular air coolers up to 1 x 0.74 x 0.3 m having from 6 to 18 tubes in the air flow as well as various flow configurations are summarized in tabular form. The test data from a number of air coolers show: in the majority of cases, the state of the air at the system outlet was close to saturation, while the air moisture content at the cooler outlet practically did not change, even with frost formation; the heat transfer coefficient changed little with a constant air rate of flow through the cooler in the presence of frost formation, though the aerodynamic resistance increased by a factor of 10 or more; the rate of growth of the thickness of the frost layer on the fins of the equipment depends primarily on the air moisture content, the cooling surface temperature and the spacing between the fins; the thickness of a frost layer is not the same for the different rows of the air cooler. The test data demonstrate the capability of improving drying process efficiency by means of cooling in tubular finned air coolers while simultaneously extending the effective drying range at subfreezing temperatures. Figures 2; references 4: 3 Russian, 1 Western.

8225/9835
CSO: 1861/340

UDC 621.952.5-111.2-229.2-539.433

SELECTION OF OPTIMAL STIFFNESS OF SUPPLEMENTAL SUPPORTS INSTALLED ON BORING BAR OF DEEP-BORING MACHINE TOOL

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 3, Mar 86 (manuscript received 5 Sep 85) pp 131-145

[Article by B.G. Makarov, candidate of physical-mathematical sciences and N.S. Silin, engineer]

[Abstract] Transverse oscillations of the boring bar in machine tools for drilling deep holes are suppressed by installing supports directly on the bar; these supports either rest on the surface of the drilled hole or in guides which guide the drill head at the start of the machining operation and support the boring bar as the head moves away from the face of the workpiece. Transverse oscillations of the boring bar occur which are primarily due to the cutting forces and the kinematic excitation through the guide supports. This paper solves fourth order partial differential equations of motion for the boring bar-support system to determine the transverse displacements of the bar as a function of the stiffness of the system consisting of the workpiece, boring bar and support assembly. The equations describing the optimal rigidity of the support assembly and its positioning on the boring bar are solved numerically on a YeS-1033 computer. Sample calculations of

the optimal stiffness of such systems are given for 22 mm diameter holes using boring bars with dimensions of 20 x 30 x 1,000 mm. This approach also minimizes the amplitudes of the transverse oscillations and the angular displacements of the end of the bar. Figures 3; references 6: Russian.

8225/9835
CSO: 1861/340

UDC 62-231.225:621.9

PROBABILISTIC ESTIMATE OF FRICTIONAL FORCE WORK IN METAL CUTTING MACHINE TOOLS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 3, Mar 86 (manuscript received 12 Jun 85) pp 158-160

[Article by Ye.T. Tulekbayev, graduate student]

[Abstract] The vibrational energy that must be dissipated in machine tools is due in the majority of cases to the external friction at points where surfaces make contact. The parameter used to describe the energy dissipation in the contacting parts is the relative energy dissipation, equal to the ratio of the work done at the contact point (that characterizes the frictional force work) to the potential energy of the system. Existing methods of designing energy absorbing systems to dissipate such vibrational energy do not adequately reflect the contribution of frictional force work. This paper briefly analyzes the shock absorbing parameters of a machine tool support system, taking frictional force energy into account, using a probabilistic approach to consider the probable indicators of the topography of the contacting surfaces when calculating elastic and plastic deformations. The technique improves the accuracy of design calculations of the dynamic performance of a machine tool. A simple example of the computation of the frictional work on a YeS 1022 computer for a nut-and-screw feed drive is cited: with a maximum load of 500 kgf and a tension on the drawbar of the feed system of 50 kgf, the relative energy dissipation ratio was 0.67 when the roughness of the contacting surfaces was Ra = 0.5 to 2 micrometers. Figures 1; references 4: Russian.

8225/9835
CSO: 1861/340

UDC 620.193.01:539.538

INHIBITING HYDROGENATION OF MACHINE PARTS DURING ABRASIVE WEAR IN CORROSIVE MEDIA

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 9, Sep 86 pp 30-32

[Article by Yu.A. Yevdokimov, doctor of technical sciences, V.I. Kolesnikov, candidate of technical sciences, and A.V. Chelokhyan, candidate of technical sciences]

[Abstract] Hydrogenation of a steel surface in an acidic corrosive medium have been found to be most intense during abrasion of the surface with attendant friction and wear. The feasibility of inhibiting this detrimental process by cathodic polarization of the surface was studied first on St45 plain carbon steel and then on GruT-8m sump pumps. These pumps have an impeller made of 40CrNiSi cast steel, an inner casing made of the same steel, and an outer casing made of cast iron and low-carbon steel. Two zinc electrodes were installed here, one bolted to the head thrust disk and one bolted to the suction thrust disk, and one aluminum electrode was bolted to the impeller hub. Under typical dredge service conditions, in a soil with abrasive particles up to 2 mm in size, cathodic polarization of surfaces subject to friction and wear was found to lengthen the life of an impeller by a factor of 1.5, that of a head thrust disk by a factor of 2.3, that of a suction thrust disk by a factor of 2.1, and that of an inner case by a factor of 1.7. Figures 3; references 6: Russian.

2415/9835
CSO: 1861/21

UDC 620.178.162:621.865.8

METHOD OF INCREASING WEAR RESISTANCE OF MACHINE PARTS FOR ROBOT CONSTRUCTION

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 9, Sep 86 pp 32-33

[Article by V.I. Butenko, candidate of technical sciences, and G.L. Kuzmin, engineer]

[Abstract] Industrial robots for forging and pressing operations were studied, in search of ways to increase the wear resistance of their components and thus lengthen their service life. Experience has shown that surface roughness is the principal determining factor and that wear during the run-in period is more critical than wear during steady-state operation. An analysis of the data has yielded an empirical relation for the run-in wear $W_{ri} = C_w t^a p^b v^c k_w$ (C_w- coefficient dependent on hardness of rubbing surfaces, t- run-in time, dependent on initial surface roughness, p- pressure, v- rubbing velocity, k_w- coefficient of lubricant). Further mechanical tests have yielded values of coefficients and exponents in this relation for predicting

the wear resistance in various robot operations but also improving it 30-40% by design. The graphonumerical procedure is demonstrated on St45 plain carbon steel, a principal material used for robot construction. Figures 1; tables 2; references 5: Russian.

2415/9835
CSO: 1861/21

UDC 621.9.06-114.08

MEASURING HEADS FOR MULTIPURPOSE MACHINE TOOLS

Moscow STANKI I INSTRUMENT in Russian No 8, Aug 86 pp 13-15

[Article by G.M. Trompet and V.V. Kuvshinskiy]

[Abstract] A new line of position measuring heads for multipurpose machine tools has been developed at the Ural Polytechnic Institute which combines reliable contact between feeler gage and machined surface with structural simplicity and reliable coupling to the electronic readout circuit on the control panel. The heads measure deviation of the machined surface from the position of the cutting edge of a tool after the latter has been shifted according to a specific program. The line includes a single-contact one-coordinate head for monitoring hole diameters 60 mm and larger, a double-contact one-coordinate head for monitoring hole diameters 3 mm and larger, and a two-coordinate head for measuring up to 1.5 mm large deviations of a surface accurately within 0.003 mm. These heads are characterized by high sensitivity and fast response necessary for precision machining. They have been tested at the Ivanovo Machine Tool Manufacturing Plant imeni USSR Semicentennial and at the Odessa Precision Machine Tool Manufacturing Plant imeni 25th CPSU Congress. Figures 2.

2415/9835
CSO: 1861/49

UDC 62-83:658.52.011.56.012.3

HIGH-SPEED ELECTRIC DRIVES

Moscow STANKI I INSTRUMENT in Russian No 8, Aug 86 pp 12-13

[Article by M.Ye. Golts, B.V. Gulymanov, L.A. Shpigler, and V.M. Sitnichenko]

[Abstract] Conventional electric drives for NC machine tools are not necessarily suitable for industrial robots in flexible manufacturing systems. Mechanisms of automatic manipulators are generally less stiff and therefore have lower natural frequencies, while they are generally required to operate

under widely variable inertia loads and at high linear velocities within a much shorter cycle time. In order to meet these requirements, it has been necessary to develop special electric motors capable of delivering linear velocities up to 5 m/s, with an up to 500% pull-out torque capacity for fast acceleration and deceleration up to 10 m/s^2. They operate preferably with a control voltage not linearly but more intricately dependent on the speed that minimizes the amplitudes of low-frequency resonance vibrations. These motors include the DPU with disk armature (1-3.6 N·m and 3000 rpm nominal), the DPM with cylindrical armature (0.8-5.2 N·m and 1500 rpm nominal), the DPM with MV_3-80 flex-gear reducer (90-140 N·m and 18.1-7.2 rpm nominal), both DPM and DPU with ball-and-worm pair (3500-5000 N and 9-18 m/min nominal), and a linear d.c. motor (800 N and 10 m/min nominal). The drive package includes besides the motor a speed regulator with tachometer-generator, a current regulator with relay, a current direction regulator with relay, a power supply, devices to safeguard against overvoltages, thermal overloads, short circuits in any one transistor switch, loss of phase, loss of speed, or overvoltage across filters in the power rectifier, and an emergency brake which through a relay also communicates with the numeric program control of the machine tool. Figures 1; references 2: Russian.

2415/9835
CSO: 1861/49

UDC 531.781+531.768

TRANSDUCER OF MECHANICAL IMPEDANCE WITH MEASURING CIRCUITRY

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 8, Aug 86 pp 35-36

[Article by L.B. Gonoradskaya, V.B. Gorelik, A.A. Pavlov, and Ye.V. Tokarev]

[Abstract] The authors have developed a piezoelectric instrument transducer of mechanical impedance which combines a dynamometer and an accelerometer in a single head. The latter contains two piezoelectric crystals separated by a buffer mass and also an electrodynamic vibrator. This head and associated circuitry measure the frequency characteristics of the mechanical impedance modulus, anddthe phase shift between its real and imaginary components. The vibrator generates harmonic perturbation forces which are applied to the test object, with smooth frequency regulation over the 1-5000 Hz nominal transducer operating range. Voltages proportional to the charges on the piezoelectric disks are transmitted to op amps and then summed for precise force and acceleration readings, the force signal being in the process converted into a velocity signal. An analog voltage divider and a detector yield the modulus of mechanical impedance, while the phase difference between force and velocity is read by a phase meter. The entire instrument is designed for operation not only with harmonic signals but also with white noise or other signals, which requires only standard accessories. The sensitivity of the transducer head is 3 $mV \cdot s^2/m$ (acceleration) and 250 mV/N (force). Figures 2; tables 1; references 3: Russian.

2415/9835
CSO: 1861/45

UDC 621.762.4:669.3:621.3

REPROCESSING OF METAL CHIPS

Kiev TEKHNOLOGIYA I ORGANIZATSIYA PROIZVODSTVA in Russian No 3, Mar 86 pp 49-50

[Article by A.I. Raychenko, doctor of technical sciences, A.S. Morozov, engineer, I.N. Tomchak, engineer, N.I. Lysakovskiy, engineer, and A.Ya. Oltarzhevskiy, engineer]

[Abstract] For improvement of overall metal economy, reprocessing of metal chips and other industrial scrap is considered as means of reducing waste which now amounts to 9 million tons. Reprocessing is aimed either at delivery of secondary raw metal to the foundry or at delivery of ready-made machine parts and tools to the workshop. Reprocessing involves essentially removal of chips from the cutting zone, transporting and sorting them, degreasing them, magnetic separation, crushing, and pelletization. Conventional techniques are removal of chips pneumatically or by fluid jet, transporting them on variously driven suitable conveyors while sorting them, degreasing them in rotary drums or gravity tanks, crushing to 10-50 mm size for better compaction. Pelletizing is done by hot or cold preforming. depending on whether the chip material is less or more plastic, hot compaction being an alternate method. The principal drawback of reprocessing chips by these conventional methods is discontinuity and therefore low productivity. New methods of hot or cold reprocessing in a continuous operation are being now developed. One of them is continuous cold compacting in a conical die. Another method, particularly suitable for chips of nonferrous metals, is electrical preheating and sintering with current passing through the chip mass. A major problem in electrical reprocessing of chips is their adequate degreasing and crushing. Most expedient is direct application of powder-metallurgical methods to crush chips for production of machine parts. Experimental specimens of rings (2.5 mm thick, 25 mm outside diameter) and bars (50 mm long, 5x5 mm^2 cross-section) produced at the Institute of Problems in Mechanics (UkSSR Academy of Sciences) have electrophysical properties comparable with but mechanical properties still inferior to those of such parts made of conventional solid metal. Neither has there still been found an effective method of removing oxide films from the chip surface. The new technology and its problems are being studied at the Novocherkassk Polytechnic Institute, the Yerevan Polytechnic Institute, the Leningrad Institute of Machining Processes "Mekhanobr", and at the Central Scientific Research Institute of Ferrous Metallurgy imeni I.P. Bardin.

2415/9835
CSO: 1861/46

UDC 621.311.22.658.004.2

SIMULATORS OF REGULATION SYSTEM COMPONENTS AND SYNCHRONIZATION FOR TRAINING DEVICE IN POWER PLANT

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 86 pp 9-11

[Article by G.G. Glovatskiy, candidate of technical sciences, Yu.A. Kens, candidate of technical sciences, Ya.D. Dembitskaya, engineer, and V.P. Kidyba, engineer, Lvov Polytechnic Institute]

[Abstract] A central training device, the principal element of a learning-and-training center for power plant personnel, consists of a computer complex, a plant control panel, an instructor's panel, and a set of simulators. The simulators in the learning-and-training center run by the UkSSR Ministry of Energy are classifiable into several functional groups. Simulators of regulation system components duplicate the real characteristics of their originals accurately and in real time. A typical one, a logic-dynamic model of an electric regulator circuit, consists of a reversible 8-digit 256-counter, a master oscillator with a frequency divider, three logic multipliers, two logic adders, three SR-triggers, and a control switch. The other groups are simulators of monitoring and measuring devices, simulators of normal process and fault signalization, simulators of switching with lighted mnemonic indicators, and simulators of manual synchronization. Many of the simulators were originally analog devices, but have been converted to digital version so as to be compatible with the now-indispensable computer. The principle of simulation is easily extendable to logic-dynamic models of mechanical steam generator or turbine components. Figures 2; references 2: Russian.

2415/9835
CSO: 1861/53

UDC 621.311.6:621.375.8

QUALITIES REQUIRED OF POWER SUPPLIES FOR GAS LASERS

Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 8, Aug 86 pp 43-46

[Article by N.S. Shchepina, engineer, Moscow Institute of Power Engineering]

[Abstract] Power supplies for electrical discharge pumping of gas lasers must be designed to ensure stability of the "pump - gap" system, which requires a large negative dynamic resistance to match the drooping current-voltage characteristic of the discharge gap. The power supply must also be fast-acting, adequate for voltage and current regulation over typically a 1:2 range and a 1:5 range respectively. For technological lasers, moreover, voltage and current fluctuations must not exceed 3% at operating frequencies

up to 100 Hz and 20% at operating frequencies above 1 kHz. A power supply with dropping current-voltage characteristic can be achieved by means of a resistive or inductive ballast in series with the load, by use of a parametric current source on the basis of reactive impedance transformation, or by means of compensation. The last method is most expedient and versatile, one possible variant being to have a high-frequency inverter (d.c. to 50 Hz a.c.) and a high-frequency rectifier coupled through a matching transformer connected between the line rectifier and the load with direct feedback from load to inverter. Use of a fixed line rectifier, thus having no phase regulation at the inverter input, allows the power supply to operate at the optimum power factor. Figures 1; references 6: all Russian.

2415/9835
CSO: 1861/36

UDC 621.886.4.001.24

VIBRATION-ABSORBING CHARACTERISTICS OF METAL-POLYMER SHELLS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 8, Aug 86 (manuscript received 13 Feb 86) pp 38-43

[Article by V.M. Chernyshev, candidate of technical sciences, docent]

[Abstract] The vibration-absorbing characteristics of metal shells with highly elastic polymer damper coatings are calculated by the energy method on the basis of Kirchhoff-Love hypotheses, rigorously enough for engineering analysis and design. All layers of the generally multilayer coating are assumed to cooperate so that all strain components are continuous functions of the space coordinates, assuming also a plane state of stress. The resonance modes of coated shells are the same as the natural modes of homogeneous shells without inelastic damping, in accordance with Wiedler's rule. The amplitude dependence of the absorption coefficient obtained by this method for circular cylindrical steel shells coated with polymer materials such as iridescent (Raduga) or VML-25 grade is compared with experimental data. A shell reinforced with heavy rings at the upper end was vertically hanging on two strings between two a.c. electromagnets, to satisfy Navier boundary conditions. The experimental equipment included a low-frequency signal generator with preamplifier and power amplifier, a set of resistance strain gages, a frequency meter with two imputs, a microvoltmeter, and a light-beam oscillograph. The agreement is close, the results indicating suppression of almost the entire vibration spectrum but most effectively of the flexural higher-order modes. Figures 3; references 7: all Russian.

2415/9835
CSO: 1861/29

UDC 621.527

LOSSES DUE TO UNDERRECUPERATION DURING STARTUP OF THROTTLE-TYPE MICROCOOLERS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 7, Jul 86 (manuscript received 30 Jan 86) pp 86-89

[Article by Yu.N. Kilimnik, engineer]

[Abstract] Since the design of cryogenic apparatus is determined essentially by requirements for its performance during start-up, a simple mehtod of calculating the underrecuperation loss during this period is proposed which does not require à priori data on its steady-state running performance. The method is applied to a throttle-type microcooler, a heat exchanger consisting of finned tubes wound on a core and separated by shell disposed in a thermally insulating vessel, with high-pressure coolant flowing through the tubes and low-pressure coolant flowing between the tubes. The heat balance along the heat exchanger is calculated thermodynamically, assuming that each coolant is under constant pressure and the heat transfer coefficient with which each operates does not vary throughout the entire length of the heat exchanger. On this basis is then calculated the magnitude of underrecuperation, namely the temperature drop at the hot end, as a function of the cooling temperature over the 300-80 K range, with the difference between high-pressure coolant and low-pressure coolant temperatures as parameter. It also depends on the rate of coolant flow and the surface area of the heat exchanger. Calculations by this method agree very closely with experimental data and yield a smaller underrecuperation than do calculations based on the steady-state performance. Figures 1; references 5: all Russian.

2415/9835
CSO: 1861/22

UDC 621.515.004.68.003.1

METHOD OF ALTERING CHARACTERISTICS OF CENTRIFUGAL COMPRESSOR

Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 7, Jul 86 pp 7-8

[Article by A.A. Zaretskiy, engineer, and Yu.K. Zasykin, engineer, PTPYralenergochemet [Ural Regional Administration of Power Systems for Ferrous Metallurgy]

[Abstract] Centrifugal oxygen compressors operating in plants of the Magnitogorsk Metallurgical Combine imeni V.I. Lenin have been found to undercompress the gas, typically to only 16 kgf/cm^2 instead of the nominal 35 kgf/cm^2, and thus operate at a 15% lower than expected efficiency. A method of altering the compressor characteristic is therefore proposed which will not only restore its efficiency by reducing the power requirement for cooling but also reduce the fire hazard. The proposal is to decrease the number of active compression stages and utilize the idle stages for

cooling, at pressures which the compressor can successively develop without each of those stages. Those stages, in turn, are cooled by gas coming from the suction line. Such an arrangement saves cooling energy and eliminates the need for regulation of the cooling gas rate by means of guide or diffuser vanes. Stages are closed and opened by means of extra valves, without shutdown of the compressor, and connections are made in the piping to allow changing the direction of flow. Such an arrangement requires some changes of pipe sizes as well as some redesign of fitting and seals. It was first tested on nitrogen compressors and then implemented on all KTK-12.5/35 oxygen compressors of the Magnitogorsk Metallurgical Combine, at a cost of 13,425 rubles for 10 units. Figures 1.

2415/9835
CSO: 1861/19

UDC 621.313.323.001.24

ELECTRIC MOTORS WITH ELECTROMECHANICAL SPEED REDUCTION AND RECTIFIED FIELD EXCITATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 4, Jul-Aug 86 (manuscript received 20 Jul 83, after revision 3 Jul 85) pp 95-105

[Article by V.V. Varley, Moscow]

[Abstract] The theory of a synchronous repulsion motor with a rolling cylindrical rigid or flexible rotor and operating from a full-wave rectified power supply is explained, its performance being analyzed on the basis of magnetic circuit configuration and energy characteristics. The condition for transfer of useful power from stator to rotor is established and the electromagnetic forces are calculated which produce useful torque. The output constants are shown not to depend significantly on "splitting" of the magnetic circuit which reduces the speed. Vibrations are also reduced, despite the voltage ripple, and the motor can be designed for a 41% higher rectified than constant voltage without an increase of losses. Figures 5; references 7: all Russian.

2415/9835
CSO: 1861/44

UDC 621.452:681.521.34

EFFECTIVENESS OF VIBRATION SUPPRESSORS FOR HYDRAULIC LOOPS IN CONTROL SYSTEMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian
No 4, Jul-Aug 86 (manuscript received 2 Jan 85) pp 147-154

[Article by A.G. Gimadiyev, Ye.V. Shakhmatov, and V.P. Shorin, Kuybyshev]

[Abstract] The performance of vibration suppressors in hydraulic loops of control system can be described by a general correction factor, namely the ratio of Laplace transforms of postsuppression and presuppression operating fluid parameters. Such a loop is analyzed according to control theory, upon introduction of the relevant transfer functions. The frequency characteristic of the allowable insertion damping a special instance of the correction factor, is calculated and an inverse Laplace transformation yields the allowable relative deviation of a control parameter in the time domain as the regulation quality criterion. Figures 3; references 3: all Russian.

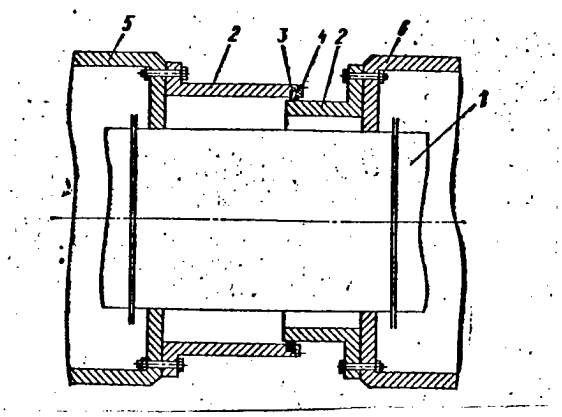
2415/9835
CSO: 1861/44

IMPROVEMENT OF OIL SEALS OF TURBINE

Moscow ENERGETIK in Russian No 7, Jul 86 p 35

[Article by engineer A. Ya. Blinov, Orsk TETs-1]

[Text] Existing flange-type oil seals of turbines and generators are hardly effective. Oil leaks from the seals due to gaps between the turbine (or generator) shaft and the flanges of the seals.



Oil Seal Chamber: 1--Turbo generator shaft; 2--oil seal housing; 3--rubber oil seal; 4--oil seal clamp ring; 5--housing of turbine bearing; 6--housing of generator bearing

Manufacture, repair and run-in of these seals are laborious and require high skills of repair personnel.

The innovators of the Orsk TETs-1 replaced the flange-type oil seals on VR-25 and VPT-25-3 turbines with an oil seal chamber (see figure). Oil leaks from the seals were completely eliminated.

6521
CSO: 1861/26

UDC 621.671-251(088.86)(47+57)

TURBINE EFFECT IN IMPELLER OF INTERMEDIATE SPEED IMPELLER PUMP WITH OVEREXPANDED INLET FLOW PASSAGE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 4, Apr 86 (manuscript received 9 Oct 85) pp 67-70

[Article by I.V. Matveyev, candidate of technical sciences and M.N. Zharkov, engineer]

[Abstract] The intake performance of an impeller pump can be improved by overexpanding the flow passage at the inlet and thinning the inlet edges of the impeller blades. The design of the intake passage and blade shape is usually based on conformal mapping; in this case, the exterior streamline makes a small angle with the centerline of impeller shaft and the profile angle is constant near the outlet. Unfortunately, a turbine effect occurs in the outer streamlines, making it impossible to employ the traditional conformal design method of I.V. Matveyev and S.S. Rudnev. This paper is mathematical demonstration of the inapplicability of the above method when the turbine effect is present and also determines the parameters governing this effect in such impeller pumps. Figures 2; references 1: Russian.

8225/9835
CSO: 1861/374

UDC 532.517.4

SPECTRAL CHARACTERISTICS OF TURBULENCE IN ROTATING CHANNELS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 50, No 4, Apr 86 (manuscript received 29 Dec 84) pp 547-554

[Article by I.M. Korshin, Kazan Institute of Chemical Technology imeni S.M. Kirov]

[Abstract] For an analysis of the turbulence spectrum in rotating radial channels, the equation of turbulence energy balance is formulated for an

incompressible fluid in such a channel taking into account fluctuation of the Coriolis force as well as temperature fluctuation. Assuming $\langle u'v' \rangle = -K\partial u/\partial y$ for the correlation of velocity components (u- mean longitudinal velocity in x-direction, v- mean transverse velocity in y-direction, z- axis of rotation), the Kolmogorov equation of momentum for locally-uniform turbulence is added and both equations are solved so as to yield the turbulence spectrum according to the Monin-Heisenberg theory. The solution reveals a 5/3-law or 11/5-law spectrum with correspondingly a 5/3-law or 7/5-law temperature spectrum depending on the relative magnitudes of two thermohydrodynamical parameters characterizing the flow pattern. A comparison of theoretical results with experimental results based on measurement with a Bruehl-Kjer analyzer and processing on an "Odra" computer indicates a close fit. Figures 3; references 8: all Russian.

2415/9835
CSO: 1861/492

UDC 621.313.332-81.018.782.3.001.5

DYNAMIC STABILITY OF ASYNCHRONOUS-SYNCHRONOUS TURBOGENERATORS WITH VARIOUS STRUCTURES OF EXCITATION SYSTEM

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 3, May-Jun 86 (manuscript received 18 Apr 85) pp 3-11

[Article by I.A. Labunets, T.V. Lebedeva, A.P. Lokhmatov, Yu.G. Shakaryan, and B.L. Shapiro, Moscow]

[Abstract] Asynchronous-synchronous turbogenerators are considered for electric power systems, because of their ability to absorb excess reactive power during fault or maintenance shutdown more economically than "shunting" reactors or reversible static compensators used with synchronous machines and than induction machines also requiring reversible static compensators for voltage regulation. The transient performance and particularly the dynamic stability of such a turbogenerator, typically a 200 MW machine with d-axis and q-axis field windings energized through two thyristor bridges each for automatic excitation control, is analyzed on the basis of a simple model of a power system and the corresponding equivalent circuit diagram. A comparative evaluation of four excitation modes reveals that reversible excitation along both axes is desirable and nonreversible excitation along the one axis (d or q) with reversible excitation along the other is adequate, but nonreversible excitation along both axes is inadequate just as is nonreversible d-axis excitation of a synchronous turbogenerator. Figures 4; references 16: 15 Russian, 1 Western.

2415/9835
CSO: 1861/491

UDC 621.313.013.001.24

CALCULATING MAGNETIC AND THERMAL FIELDS IN ELECTRICAL MACHINES AND APPARATUS BY METHOD OF EXCLUSION WITH SEPARATION OF REGIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian
No 3, May-Jun 86 (manuscript received 21 Jan 85) pp 84-91

[Article by R.M. Nemeni, Moscow]

[Abstract] Calculating magnetic and thermal fields in electrical machines and apparatus with a finite central differencing scheme and exclusion of internal points in regions, although one of the fastest and most effective direct methods, becomes inadequate when the number of grid nodes in one direction is sufficiently large to cause instability of the computation process. A remedy is exclusion with separation of regions, which can be done either by exclusion of internal points in the separate region or by representation of the field in the separate region in difference form analogous to Fourier series. Both procedures are demonstrated by calculating the field in a rectangular slot containing copper only, with insulation disregarded, between rectangular magnetically-unsaturated iron teeth. Both procedures, applicable to magnetic and thermal fields alike, have been programmed for the BESM-6 high-speed computer at NIS Gidroproyekt [Scientific Research Department of the All-Union Planning, Surveying, and Scientific Research Institute of Hydro Engineering imeni S.Ya. Zhuk] as well as for the YeS-1022 computer at the Yerevan Polytechnic Institute. Figures 3; references 6: all Russian.

2415/9835
CSO: 1861/491

UDC 621.165-226.2.01:536.423

CONDENSATION INSTABILITY IN NOZZLE ARRAYS WITH NARROWING PASSAGES

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian
No 3, May-Jun 86 (manuscript received 8 May 85) pp 142-150

[Article by M.Ye. Deych, A.V. Kurshakov, V.M. Leonov, and A.A. Tishchenko, Moscow]

[Abstract] Supersonic flow (Mach number $N_M > 1.10$) of superheated steam through narrowing passages of nozzle arrays with attendant fluctuation of static pressure and spontaneous condensation of subcooled steam is analyzed, on the basis of a structure which includes three rarefaction waves and four condensation or adiabatic compression shocks recorded on Töpler schlieren photographs during experiments with S-9012A and S-9012Aws (wet steam) nozzles at the Moscow Institute of Power Engineering. The amplitude of pressure fluctuations was measured as a function of frequency over the

400-4000 Hz range and of thepressure ratio over the 0.1-0.7 range for saturated steam ($\Delta T = 0°C$) and superheated steam ($\Delta T = 46°C$, $65°C$). It was found to be peaking within these ranges. The experimental data thus confirm the hypothesis that separation from the nozzle surface occurs at the blade tips as a result of condensation or adiabatic shock, with attendant parametric resonance when the frequency of pressure fluctuation within the separation zones becomes equal to or a multiple of the frequency of pressure fluctuation in the vortex trails behind those blade tips. The analysis of experimental data also indicates the necessity of applying here a two-dimensional theory rather than a simpler but quite inadequate one-dimensional one. Figures 4; references 13: all Russian.

2415/9835
CSO: 1861/491

UDC 621.515

INFLUENCE OF BLADE DIFFUSOR SURFACE ROUGHNESS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 86 pp 9-11

[Article by Engineers B.A. Zvanets and S.V. Tsukerman]

[Abstract] Results are presented from tests of an end-type centrifugal compressor stage with blade diffusor. The roughness of the blades of one diffusor stage was varied during the test. Three roughness values were used: rough milled with roughness 0.035 mm; hand ground with roughness 0.012 mm; and polished with a pneumatic hand polisher, roughness 0.0018 mm. The relative loss coefficient was determined as the ratio of the diffusor loss coefficient at the initial value of roughness to the loss coefficient at the finest value (hydraulically smooth surface) produced by polishing. The results allow a well-founded approach to selection of surface smoothness, and can be applied to centrifugal compressor stages as well. Figures 3; references 6: all Russian.

6508/9835
CSO: 1861/60

UDC 621.515.001.5

RESULTS OF EXPERIMENTAL STUDIES OF AXIAL-RADIAL CIRCULAR TURBINE CHANNELS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 86 pp 11-14

[Article by Candidate of Technical Sciences A.A. Nikitin]

[Abstract] A study is made of the results of experimental investigation of energy losses in axial-radial circular channels in the area of low degrees of expansion and with confusor flow, obtained with an axisymmetrical flow entering the channel at Reynolds No $1\text{-}2\cdot10^5$, Mach number < 0.35. Experiments were performed at hub ratios of 0.37, 0.43, 0.48, 0.56, 0.69 and 0.75. The optimal value of radius of the volute surface, providing minimum energy losses, was found to be between 0.5 and 1+r (radius of curvature of convex channel wall). The results of the studies can be used to calculate energy losses in axial-radial circular channels with confusor factor 0.53-4.07, mean radius of curvature 0.7-2.35 and mean diameter 0.47-0.83, operating at the Reynolds and Mach number values tested. As confusor coefficients decreases, energy losses in these axial-radial channels increase more slowly at values less than 1, whereas increases in confusor coefficient in the area greater than 1 cause slower decreases than in radial-axial channels. Figures 4; references 7: all Russian.

6508/9835
CSO: 1861/60

UDC 621.515.001.2

THERMODYNAMIC EFFICIENCY OF COMPRESSORS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 86 pp 14-15

[Article by Engineer V.G. Solovyev]

[Abstract] A study is made of the process of compression of gas in an uncooled compressor. A method is suggested for determining the efficiency for both cooled and uncooled compressors in which the ideal process of gas compression in a cooled compressor is assumed to be a process allowing the gas to be converted from its initial to tis final state by means of reversible processes with minimum expenditure of work. An equation is presented for the polytropic efficiency of the final stage of a compressor. The thermodynamic efficiency cannot be used to compare two compressors if one has intermediate cooling while the other does not. Figures 4; references 4: all Russian.

6508/9835
CSO: 1861/60

UDC 699.841:621.671

STUDY OF SEISMIC STABILITY OF TYPE KsV PUMPING UNITS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 86 pp 26-28

[Article by Engineer A.D. Tsëma]

[Abstract] A method is suggested for construction of a calculation model to solve the problem of stability against tipping and shifting of type KsV pumping units in response to horizontal components of seismic loading. The calculation model of the unit consists of absolutely rigid rods connected together and to a foundation by elastic hinges with known angular rigidities. The produces a rod branched system with four degrees of freedom relative to the generalized coordinates. The calculations and experimental studies indicate that only the first natural frequency of oscillations of the units is in the area of seismic resonance. The error in calculating the first resonant frequency depends primarily on the accuracy of determination of the effective rigidity. The seismic stability of these types of structures can be improved by detuning the lower resonant frequencies from the zone of seismic resonance. Figures 2; references 4: all Russian.

6508/9835
CSO: 1861/60

UDC 621.43

DYNAMIC PARAMETERS OF TRANSPORT VEHICLE DURING ACCELERATION

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 3, Mar 86 (manuscript received 30 Sep 85) pp 90-94

[Article by O.B. Leonov, professor, candidate of technical sciences and V.V. Goltsov, engineer]

[Abstract] The dynamic properties of a rigid rotating system (in a transport vehicle, the engine and power load) are governed by the engine and load torques as well as the overall moment of inertia of the rotating masses of the system. This paper analyzes a transport vehicle power plant having a known total moment of inertia and a user load torque that is a function of the r.p.m. in order to determine the minimum possible acceleration time taking into account constraints expressed in terms of the maximum effective torque of the engine and the angular acceleration of the crankshaft as well as pollution requirements. The procedure also enables the determination of the minimum possible acceleration time for a selected engine while assuring steady-state performance parameters, the determination of the shape of the external speed characteristic of the engine so as to obtain a specified acceleration, where attaining the latter requires either modernizing or replacing the selected engine. Sample calculations are provided for the

dynamic external speed performance of a 6ChN15/18 engine for an angular acceleration of 15 rad/s^2 and a maximum torque of 1,700 N·m during a run-up from 800 to 1,500 r.p.m. Figures 3; references 2: Russian.

8225/9835
CSO: 1861/340

UDC 621.514

COMPOSITE PROFILES FOR ROTARY COMPRESSORS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 7, Jul 86 (manuscript received 17 Dec 85) pp 72-75

[Article by A.M. Ibrayev, Lecturer, M.S. Khamidullin, lecturer, and G.N. Chekushkin, candidate of technical sciences, docent]

[Abstract] Geometrical design of composite profiles consisting of contiguous segments for rotary compressors by the method splines is proposed, the first step being to determine and ensure the proper succession of contact points as the two meshing runners move from one position to another. The next step is to determine and ensure technological feasibility of such profiles. Several computer programs are available which facilitate the procedure: SEVAL for calculating a cubic spline function with SPLINE for calculating its coefficients as well as its first and second derivatives at profile node points, ZEROIN for solving transcendental equations of normals, and FMIN for minimizing the clearance between driver and follower as they mesh during nonreversible rotation. The accuracy of this interpolation method can be checked against the exact analytical method, for which a universal program is also available. Figures 3; references 4: 2 Russian, 2 Western (both in Russian translation).

2415/9835
CSO: 1861/22

UDC 621.512

MODE OF LIQUID INJECTION INTO THEORETICAL POSITIVE-DISPLACEMENT COMPRESSOR WITH TWO-PHASE WORKING MEDIUM

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 7, Jul 86 (manuscript received 11 Nov 85) pp 76-82

[Article by V.Ye. Shcherba, candidate of technical sciences, I.S. Berezin, engineer, and I.Ye. Titov, engineer]

[Abstract] Injection of cooling liquid is considered as means of increasing the efficiency of positive-displacement air compressors, by making the compression process more nearly isothermal and minimizing the leakage of compressed air so as to also allow a size and weight reduction. Disregarding the usually negligible evaporation of injected liquid and thus assuming a two-phase working medium without phase transitions of the first kind, the correct mass of liquid with known specific heat is determined on the basis of thermodynamic laws governing the desirable compression process. The correct mode of liquid injection during compression is accordingly determined for an ideal isothermal compressor as well as for an optimum real polytropic one, first disregarding the change of gas volume caused by injection of liquid and then, more precisely, including the volume of injected liquid in the compression chamber. Numerical calculations have been made for injection of water into rotary and reciprocating air compressors. Figures 2; references 5: all Russian.

2415/9835
CSO: 1861/22

UDC 629.7.02;539.4

TWIST OF COMPRESSOR BLADES MADE OF COMPOSITE MATERIAL

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 7, Jul 86 (manuscript received 3 Jan 86) pp 82-85

[Article by Ye.L. Demyanushko, graduate student]

[Abstract] Performance analysis of compressor blades made of a composite material and designed for torsional strength involves determination of their necessary intrinsic twist for the optimum angle of attack as well as of their additional deplanation caused by centrifugal and aerodynamic forces. Stress and strain analysis according to the Timoshenko theory of torsion for non-homogeneous elastic beams and on the basis of a specific cross-section geometry is followed by application of both Lagrange and Castigliano principles, which yield respectively upper-bound and lower-bound estimates of torsional stiffness. Calculations have been programmed in FORTRAN language for variable parameters of blade cross-section (initial twist

angle, radius of curvature, maximum chord, number of material layers, thickness of layer), variable blade material, and variable nominal pressure load, with a blade subdivided typically into eight segments. Figures 2; tables 1; references 4: 3 Russian, 1 Western (in Russian translation).

2415/9835
CSO: 1861/22

UDC [621.671:621.3.019.32].004.6.001.2

COMPOSITE INDICATORS OF RELIABILITY AND REPAIRABILITY OF CENTRIFUGAL PUMPS

Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 8, Aug 86 pp 55-57

[Article by B.P. Bashurov, candidate of technical sciences, Novorossiysk Higher Marine Engineering School]

[Abstract] The concept of an operational databank as basis for equipment performance and maintenance control is applied to centrifugal pumps. Conventional quantitative indicators of their present worth are the utilization factor and the specific labor costs of routine maintenance, fault clearance, and repair. An availability factor is suggested as an additional important indicator. All these indicators are applied to the four critical elements of a pump: seal, impeller, bearing, and shaft. Typical data are given pertaining to pumps for six major applications: sea-water circulation for cooling, fresh-water circulation for cooling, feeding brine for distillation, feeding water to low-pressure boiler, pumping condensate, pumping petroleum and its products. An analysis of these data and comparative evaluation reveal that the composite reliability and repairability indicator is lowest for pumps handling sea water and highest for pumps handling fresh water. Most costly is the repair of gland seals and least costly is the repair of a shaft, respectively about 37% and 6% of the total pump restoration cost, while the mean repair time depends on the length of operation with most failures occurring during the initial break-in period and during the latter wear-out period. Figures 1; tables 2; references 5: all Russian.

2415/9835
CSO: 1861/36

UDC 621.438

TURBINES WITH COUNTERROTATING RUNNERS FOR AIRCRAFT POWER PLANTS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 86 (manuscript received 29 Jul 85) pp 50-53

[Article by B.A. Ponomarev and Yu.V. Stosenko]

[Abstract] Turbines with counterrotating runners are reviewed and compared for use in aircraft power plants. Three groups of engines with such turbines are under consideration. The first group includes a double-shaft or triple-shaft turbofan engine with minor second cycle and with or without afterburner, a turbojet engine with or without afterburner, and a small high-pressure turbine with or without low-pressure stage, usually constructed according to 1+1, 1+2, 1+1+2, or 2+2 scheme. The second group includes a turbofan engine with major second cycle, a large high-pressure turbine, and a turbopropfan engine with reducer. A turbopropfan engine without reducer constitutes the third group, its birotational version having unique kinematic characteristics and such an engine being also combined with one which has a reducer between the turbine and the propeller fan. Figures 3; references 1: Western.

2415/9835
CSO: 1861/31

UDC 629.735.083.021.03

DIAGNOSIS OF FLOW CHANNEL IN AIRCRAFT GAS-TURBINE ENGINES ON BASIS OF VIBRATION SPECTRUM CHARACTERISTICS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 2, Apr-Jun 86 (manuscript received 22 Apr 85) pp 45 49

[Article by A.G. Mironov and S.M. Doroshko]

[Abstract] A model of aerodynamic vibrations of gas-turbine engines is constructed on the basis of variable aerodynamic forces arising during action of the gas stream on guide vanes and runner blades. Nonuniformity of the flow together with structural irregularities in the guide ring and in the runner, such as variance of the blade setting angle, produces fluctuations of aerodynamic forces transmittable to the engine housing through the bearings. These forces are expressed in the form of compound Fourier series so that a recorded spectrogram will indicate the vibration sources and yield significant data about them. The principle is demonstrated on a double-shaft turbofan aircraft engine. Figures 3; references 4: all Russian.

2415/9835
CSO: 1861/31

UDC 531.385

EQUAL-MODULUS VECTOR PROGRAMMED FREQUENCY CONTROL OF MINIMALLY REDUNDANT STRUCTURE OF POWERED, SINGLE-DEGREE-OF-FREEDOM GYROSCOPES FOR SPACECRAFT ATTITUDE CONTROL SYSTEM

Moscow MEKHANIKA TVERDOGO TELA in Russian No 2, Feb 86
(manuscript received 29 Dec 84) pp 3-10

[Article by Yu.A. Karpachev]

[Abstract] Powered gyroscopic spacecraft attitude control is based on the changing of the total kinetic moment vector of the gyroscopic system (H vector) along spacecraft axes. With a known mechanical model of the spacecraft and a given or real-time synthesized attitude control program, the control of the powered gyroscopes reduces to the determination of the angular precession rates of the gyros needed to effect a programmed change in the H vector, and determination of the pulse repetition rate of the precession axis step motor drives which will produce the desired-change in precession frequency. This paper is a theoretical analysis of such programmed frequency control for a minimally redundant, coplanar gyroscopic system, in which the gyroscopes are distributed in two nonorthogonal powered gyroscope groups. The precession axes of each of these groups are parallel to each other. The basis of the gyro system control is the breaking down of the programmed H vector into two vectors of equal modulus, determined by the vector sum of the kinematic moments of the two gyroscopes with the gyroscopic suspension axes parallel to each other. The presence of these two equal-modulus vectors maximizes the gyroscopic system control range, minimizes the number of singlar states and enables the construction of simple algorithms for calculating the programmed angular precession rates of the gyroscopes. This theoretical treatment adduces neither sample calculations nor design examples. Figrues 4; references 5: all Russian.

8225/9835
CSO: 1861/376

UDC 531.1

CALIBRATION OF ATTITUDE CONTROL SENSORS

Moscow MEKHANIKA TVERDOGO TELA in Russian No 2, Feb 86
(manuscript received 22 May 85) pp 11-17

[Article by Ye.M. Potapenko, Zaporozhye]

[Abstract] Two star trackers in a spacecraft attitude control system generate output signals represented by column vector matrices. The noise in the sensors of the star trackers is assumed to be independent gaussian white noise. This paper is a theoretical analysis of the construction of simple algorithms fortthe calibration of position and rate sensors in the attitude control system of a moving craft without the necessity of identifying reference markers and without utilizing information on the orientation of the craft. With a constant absolute angular velocity vector of the craft, no more than three linear combinations of the coordinates for the vector of state of the system are observable. The state vector of the system that eliminates the need for special calibration maneuvers for in-flight calibration is found. This purely theoretical treatment adduces neither sample calculations nor design examples. References 9: 2 Russian, 7 Western, [2 in Russian translation].

8225/9835
CSO: 1861/376

UDC 539.374

FREE AND FORCED OSCILLATIONS OF ROTATING VISCOELASTIC RING

Moscow MEKHANIKA TVERDOGO TELA in Russian No 2, Feb 86
(manuscript received 4 Jul 85) pp 150-154

[Article by N.Ye. Yegarmin, Moscow]

[Abstract] A nonextensible ring rotates slowly about an axis perpendicular to the plane of the ring. The material of the ring is such that Poisson's ratio can be considered constant, while Young's modulus is replaced by some linear integral operator. This viscoelastic material then supports vibrations caused by the system driving it; the vibration standing wave can precess, both relative to the ring and relative to the inertial space, though these precession rates may differ. While the vibrations of the ring are usually decaying, a technique is proposed that allows the sustaining of such vibrations in order to produce not just a rate gyro, but also an angle transducer. The decay time for free vibrations is t and the time constant of the control system inertia is t_0. As t_0 becomes smaller and t larger, the ring becomes more independent of the system driving the vibrations. As

$t \to \infty$ the damping of the vibrations is reduced, and less force is necessary to maintain them. The time t can be brought up to around 900 sec, while t_0 can be on the order of a fraction of a second in physical systems. The influence of the excitation system can be made negligible and such a powered control system can be used in an angular rate sensor. References 6: 4 Russian, 2 Western.

8225/9835
CSO: 1861/376

UDC 662.997

FOCUSING SOLAR ENERGY COLLECTOR

Ashkhabad IZVESTIYA AKADEMII NAUK TURKMENSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 1, Jan-Feb 86 (manuscript received 18 Dec 83) pp 28-31

[Article by I. V. Baum and A. K. Nalitkin, Scientific Production Association Solntse, Turkmen SSR Academy of Sciences]

[Text] The thermal losses in solar collectors are controlled by different methods. A considerable part of the thermal losses in the collectors is through the glass coating, that is, through the top cover.

The use of concentrating mirror elements, for example, "foklins", permits an increase of the efficiency of solar collectors by increasing the energy density on the surface of the heat collector and by reducing its area. The total heat losses of the collector are reduced, the temperature on the heat-exchange surface is increased and the efficiency of conversion of solar energy to thermal energy is increased.

Let us consider a solar collector, supplied with concentrating mirror elements--foklins (Figure 1, a). A system of wedge-shaped mirrors 2, which concentrate the solar energy onto the heat collector 3, is located under the glass cover 1. The space between the mirror elements and part of the space to the bottom of the body of the collector are filled with heat-insulating material 4. The inlet of the foklin D (see Figure 1, b) is K-fold greater than the outlet (K is the geometric concentration factor of the system). The system of mirrors, correctly assembled and adjusted, concentrates the impinging solar energy within the double parametric angle 2α.

The focusing collector with concentrating elements of the foklin type has been developed and tested at the NPO [Scientific Production Association] Solntse, Turkmen SSR Academy of Sciences. The area of the inlet of the collector is 1,200 × 500 mm. There are eight focusing elements with geometric concentration on the order of 3.86 each under the glass cover. Flat silvered mirrors with inner coating and with coefficient of reflection of 0.95 were used as the reflecting elements, while the heat collectors were brass tubes 14 mm in diameter and with wall thickness of 1 mm, joined to each other in a zigzag fashion. The total inner volume of the tubes was 140 cm^3, which guaranteed low thermal inertia of the collector. This permits the collector to be brought up to stabilization of the parameters within 10-15 min upon sharp variation of solar radiation.

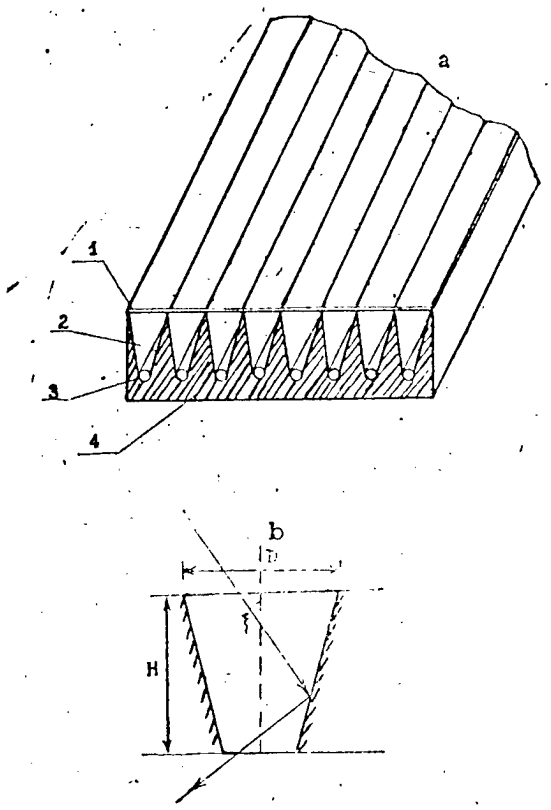


Figure 1. Cross-Section of Solar Collector With Concentrating Mirror Elements--Foklins (a)--and Diagram of Individual Foklin (b)

The summer season in Turkmenistan is characterized by constant radiation and absence of overcast. Therefore, the thermal inertia of the collector did not affect the parameters to be measured during the experiment. The body of the collector is wood and microbasalt fiber, the thickness of the layer of which was 100 mm, was used as the heat-insulating material.

The collector was tested in 1983. Its orientation was southerly with angle of inclination with respect to the horizon of 74°. This position of the collector corresponded to the maximum arrival of radiation onto the receiving surface at local noon during the entire test period. The following parameters were recorded: direct S and diffuse D solar radiation, ambient temperature (background temperature) T_0, temperature of liquid coolant at inlet T_{BX} and outlet $T_{ВЫХ}$ of the collector and also flow rate of liquid coolant (water) through the collector. All the parameters were recorded from 0900 to 1800, every half hour. The tests were conducted in several modes. Let us consider the test data in two modes.

1. The mode of determining the equilibrium temperature of the collector when the coolant flow rate through the collector is equal to zero, while the temperature of the heat collector is established as a function of the solar radiation S, maximum from the possible values for the given design.

2. Mode of heat recovery when constant or slowly variable flow rate of the coolant through the collector is established. The temperature at the outlet of the collector is higher than at the inlet, but is no greater than equilibrium.

The mean monthly course of the equivalent temperature of the collector repeats the course of direct solar radiation (Figure 2, a). This is obvious if one takes into account that the focusing elements--foklins--operate mainly with direct solar radiation. The fraction of scattered radiation in the energy balance of the focusing collector is negligible.

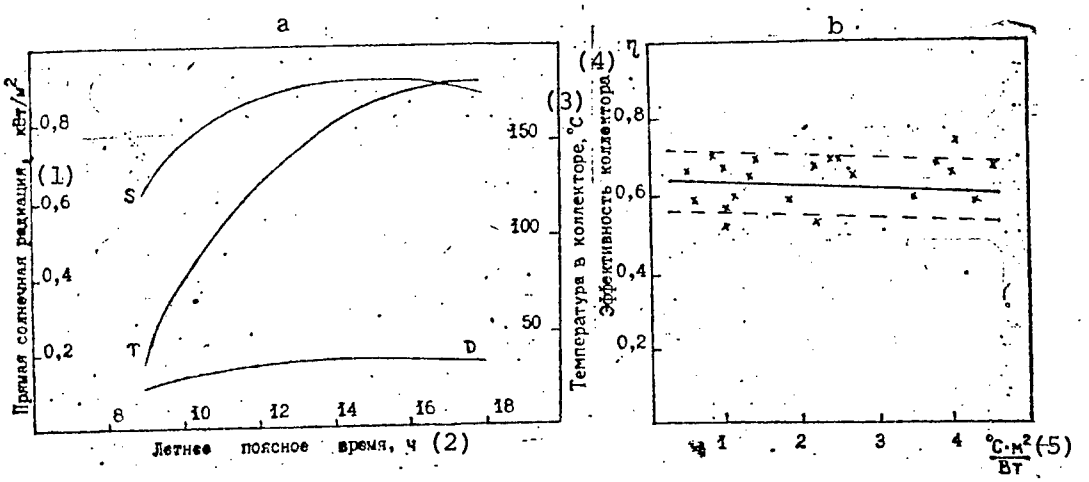


Figure 2. Mean Monthly Course of Direct and Scattered Solar Radiation and of Equilibrium Temperature of Collector (a) and Results of Processing Full-Scale Test Data in Variables x, y (b)

KEY:

1. Direct solar radiation, kW/m^2
2. Summer standard time, hours
3. Temperature in collector, °C
4. Efficiency of collector
5. $°C \cdot m^2/W$

Overheating of the heat-receiving surface of the collector above background temperature T_0, which comprised 140-150°C at the level of direct solar radiation of 0.8-0.85 kW/m^2, was recorded during the experiment. The system of foklins, located under the glass cover of the collector, sharply suppresses free convection in the space between the heat collector and the cover glass. As a result, the temperature of the heat collector is essentially independent of this cover glass. Therefore, the effective wind on the temperature mode of the collector can be disregarded and the wind velocity was not recorded during the experiment.

The coolant flow rate through the collector was recorded during heat recovery from the collector and the water equivalent of the mass flow rate was determined

$$W = C_0 \cdot \sigma \ . \qquad (1)$$

The net heat, transmitted to the coolant, was determined by the formula

$$Q_{пол}=\rho \cdot A_з \cdot \tau_{ст} \cdot F(S\cos i\tau(\xi)+\tilde{\tau}S')U_L'F(\Delta T)_N. \quad (2)$$

The mean characteristic temperature of the collector was calculated by the formula

$$(\Delta T)_N=\frac{T_{вых}+T_{вх}}{2}-T_0, \quad (3)$$

while the net heat transmitted to the coolant was calculated by using the equation

$$Q_{пол}=(T_{вых}-T_{вх})\cdot W. \quad (4)$$

The flux density of solar radiation on the heat collector with regard to the capacity of the focusing system and of the cover glass was determined by the formula

$$q=S\cdot\cos i\cdot\tau(\xi)+\tilde{\tau}\cdot S'. \quad (5)$$

However, the net heat can be represented by the flux density of solar radiation

$$Q_{пол}=q-U_L'\cdot F(\Delta T)_N, \quad (6)$$

or with regard to the capacity of the collector in the form

$$Q_{пол}=\rho\cdot A_з\cdot\tau_{ст}\cdot Fq-U_L'F(\Delta T)_N. \quad (7)$$

Since the area of the inlet is K-fold greater than that of the heat-collector area for the focusing area, then the heat loss factor, related to the area of the inlet, is 1/K as much

$$U_L'=U_L\cdot(F/F')=U_L\cdot K. \quad (8)$$

Let us introduce the variables

$$x=(\Delta T)_N d; y=Q_{пол}/F\cdot q. \quad (9)$$

Equation (7) can be written with regard to (9) in the form

$$y=\rho A_з\cdot\tau_{ст}-U_L'\cdot x, \quad (10)$$

which indicates the linearity of the relationship between the values x and y. Variable y characterizes by its physical mean the efficiency of the solar collector and variable x establishes the relationship between the thermal head ΔT and the surface density of solar radiation q.

The experimental data were processed by the least squares method on the BESM-6 computer and the correlation coefficient of variables x and y was determined, which was on the order of 0.01. The free term was 0.67 ± 0.03. The experimental points essentially do not go beyond the bounds of the confidence interval with value of 0.02. This means that the tested collector has stable parameters, measured with acceptable accuracy. The weak dependence of x on y can be interpreted as weak dependence of the efficiency of the collector on the radiation situation and on the mode of heat recovery.

The mean heat loss factor of the collector was determined by processing the experimental data.

Full-scale tests of a solar collector with focusing mirror elements showed that the given design is quite efficient and has the best operating parameters compared to ordinary flat collectors (see Figure 2, b).

The focusing collectors may find broad application in solar power plants, where constant efficiency of solar energy conversion to thermal energy is especially important. These collectors can possibly be used in the solar heating systems of buildings and the determining condition of normal operation of the collector is only a sufficient number of solar days per year. And this in turn permits one to use solar energy for heating in the European part of the Soviet Union. Because of the high equilibrium temperature of the focusing collectors, the latter can be used as steam generators at plants where there is a need for low-parameter steam.

However, mass production of solar focusing collectors has not yet been developed. The design and technology for fabricating a focusing collector with mirror elements have been worked out at the Scientific Production Association Solntse, Turkmen SSR Academy of Sciences.

The notations used were: W--water equivalent, W/°C, C_p--specific heat, J/(kgf/s); σ--coolant flow rate, kgf/s, S--direct solar radiation, kW/m^2, i--angle of incidence of solar rays on collector, $\tau(\xi)$--dimensionless angular selectivity of optical system, τ_{CT}--dimensionless transmissive capacity of glass and S'--scattered (diffuse) solar radiation, kW/m^2.

6521
CSO: 1861/527

UDC 681.795.2:536.5

COMBINED USE OF QUANTITATIVE AND QUALITATIVE REFRACTOMETRIC METHODS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 50, No 4, Apr 86 (manuscript received 14 Jan 85) pp 597-604

[Article by Ye.V. Gumennik, O.A. Yevtikhiyeva, B.S. Rinkevichyus, and Yu.D. Chashechkin, Institute of Problems in Mechanics, USSR Academy of Sciences, Moscow]

[Abstract] Combined use of a laser refractometer and a shadow interferometer is proposed for recording and analysis of dynamic effects in multilayer fluid media. Several laser refractometer have been developed for such an application, most effective being multichannel instruments and a scanning one. One variant of a multichannel laser refractometer consists of a laser, an ultrasonic Raman-Nathe light modulator, a lens converting the divergent beams from the modulator into parallel ones for passage through the medium, and behind the medium a pair of lenses controlling the distance between those parallel light beams before they impinge on a position-sensitive photoreceiver which feeds electric signals to an oscillograph. Typically an LG-52-1 laser and a 4 MHz light modulator were used in an experimental study of transient axisymmetric nonuniformtiy building up in a fluid during propagation of heat from a hot cylindrical wire. The scanning laser refractometer consists of a laser, resolution and sensitivity maximizing optics, a scanning mirror with electrically controlled tilt angle, an objective lens converting the divergent light beam from the mirror into a parallel one for passage through the medium, and behind the medium an objective lens focusing that parallel beam onto a position-sensitive photoreceiver which feeds electric signals to an oscillograph for visual-manual tuning of the photoreceiver and adjustment of mirror tilt, to a spectrum analyzer, and to voltmeter. This instrument with an oscillographic galvanometer as scanner and an IAB-458 shadow interferometer, optically coupled by two semitransparent mirrors, were used for determination of vertical profiles and gradients of quantities such as refractive index and density as well as for tracking the evolution of mixing regions. Figures 4; references 13: 10 Russian, 3 Western (1 in Russian translation).

2415/9835
CSO: 1861/492

UDC 535.31:536.52

DESIGN OF OPTICAL SYSTEM WITH HOLLOW-MIRROR LIGHT GUIDE AND DIAPHRAGMS FOR PHOTOELECTRIC INSTRUMENTS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 50, No 4, Apr 86 (manuscript received 15 Jan 85) pp 666-672

[Article by V.B. Rantsevich, Institute of Applied Physics, BSSR Academy of Sciences, Minsk]

[Abstract] An optical system consisting of a hollow cylindrical mirror as light guide with circular entrance and exit diaphragms between a large isothermal diffusely shining object and a radiation receiver on the optical axis is considered for photoelectric measurements. Light rays from the object to the receiver pass through this cylindrical light guide zigzagging either in meridional planes of the optical axis or along helices. The diameter of the sensitive receiver spot is assumed to be much smaller than the inside diameter of the cylindrical light guide so that skewed rays reaching it have been multiply reflected the same number of times as meridional rays with correspondingly the same energy loss and can, therefore, be regarded as quasi-meridional ones. On this basis and in accordance with laws of geometrical optics are derived formulas for graphoanalytical design of such an optical system as part of a photoelectric instrument such as a pyrometer. Figures 2; references 4: 3 Russian, 1 Western (in Russian translation).

2415/9835
CSO: 1861/492

UDC 543.42:621.3.019.3

INCREASING ACCURACY OF SPECTRAL ANALYSIS IN CORRELATION PROCESSING OF SIGNALS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 28, No 6, Jun 85 (manuscript received 11 Oct 84) pp 6-8

[Article by V.P. Kontorovich, Tolyatti Polytechnical Institute]

[Abstract] A study is made of a spectral analyzer with a limited number of wide band filters using subsequent sharpening of their amplitude-frequency characteristics by special processing of signals at the output of the filters, intended to achieve acceptable values of both speed and error of spectral analysis. The special processing includes time scanning of the signal at the period of one of the frequencies in the transparency band of one filter, perhaps the central one; quantizing of the signal; successive multiplication of pairs of readings; and weighted addition, the last two

operations being analogous to correlation transformation of discrete samples. The spectral analyzer produces good resolution due to the sharpening of the amplitude-frequency characteristic thus achieved while simultaneously achieving square-law detection and averaging. Computer simulations indicate that the error of spectral analysis for wide band signals should be 1-5%. References 8: all Russian.

6508/9835
CSO: 1861/476

UDC 532.5

INSTABILITY OF STEADY FLOW WITH CONSTANT VORTICITY IN VESSELS WITH ELLIPTICAL CROSS-SECTION

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 50, No 3, Mar 86 (manuscript received 27 Jun 84) pp 369-377

[Article by V.A. Vladimirov and D.G. Vostretsov, Novosibirsk]

[Abstract] The flow of an ideal incompressible and homogeneous fluid completely filling an ellipsoidal vessel with impermeable walls is described by an exact solution to the corresponding equations of motion for the velocity field with a vortex. This solution is analyzed for stability in the linear approximation, in a system of "deformed" cylindrical coordinates and in dimensionless time $\tau = \omega t$ (t- real time, ω- angular velocity). Solution of the stability problem involves determination of the response to harmonic pressure perturbations. This is done by transforming the fundamental equations of motion into an equation for pressure (as per Gledzer, Dolzhanskiy and Obukhov). Following the solution in the zeroth approximation, the conditions for instability are established in the first approximation and then in the general case. Both the problem and its solution by successive approximations are particularized for a triaxial ellipsoid of rotation. Numerical results agree closely with results of measurements and theoretical results according to Ye.B. Gledzer, F.V. Dolzhanskiy and A.M. Obukhov, in "Sistemy gidrodinamicheskogotipa i ikh primeniye" [Hydrodynamic Systems and Applications], Moscow, "Nauka" 1981. Figures 3; references 10: all Russian.

2415/9835
CSO: 1861/494

UDC 532.5:534.1

EFFECT OF DISSIPATION ON PROPAGATION OF SPHERICAL DETONATION SHOCK WAVE

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 50, No 3, Mar 86 (manuscript received 26 Jun 84) pp 384-393

[Article by V.N. Likhachev, Moscow]

[Abstract] The system of equations describing spherical wave motion of a viscous compressible fluid through a weakly compressible medium is combined with the equation of piston motion simulating the effect of detonation products. The complete boundary-value problem is solved by the method of asymptotic expansions in a small parameter ε. A solution is obtained for early dimensionless time $t \sim \varepsilon^{1/2}$ and for late dimensionless time $t \sim 1$, then for the intermediate period by collocation of asymptotes. On this basis are then calculated the dynamic characteristics of flow along the piston and are plotted shock wave profiles depending on the Reynolds number, unlike those of shock waves of an inviscid fluid, in the $N_{Re} \ll$ range. These profiles are found to be parabolic, while those in the zone of a plain wave are hyperbolic. Figures 2; references 12: 10 Russian, 2 Western (both in Russian translation).

2415/9835
CSO: 1861/494

UDC 539.374:534.1

REFRACTION OF SHEAR WAVE INTO NONLINEARLY ELASTIC OR ELASTOPLASTIC HALF-SPACE

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 50, No 3, Mar 86 (manuscript received 11 Mar 85) pp 490-497

[Article by A.G. Bykovtsev, Cheboksary]

[Abstract] The problem of dynamics in the theory of complex shear is solved for refraction of shear waves into a nonlineary elastic or, in the extreme case, an elastoplastic medium. The equations of motion with antiplane deformation and the condition of compatibility are formulated in a Cartesian system of coordinates where all displacement and velocity vectors are oriented along the x_3-axis and are functions of x_1, x_2 coordinates and time only, while all components of the stress tensor are zero except its shear components $\tau_1 = \sigma_{13}(x_1, x_2, t)$ and $\tau_2 = \sigma_{23}(x_1, x_2, t)$. The parameters of this

system of equations are assumed to satisfy the condition which makes it a hyperbolic one. The solution is compared with the author's solution to the problem of refraction of planary polarized plane shear waves at the

boundary of an elastic or elastoplastic half-space, that problem having been solved with the aid of Prandtl-Reuss equations. Figures 2; references 9: all Russian.

2415/9835
CSO: 1861/494

UDC 538.4

CANONICAL EQUATIONS OF MOTION FOR VORTICAL FLOW OF MAGNETIZABLE IDEALLY CONDUCTING FLUID

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 50, No 3, Mar 86 (manuscript received 18 Feb 84) pp 509-512

[Article by V.B. Gorskiy, Gorkiy]

[Abstract] Canonical equations and Hamiltonians of motion are derived for vortical adiabatic flow of a magnetizable ideally electrically conducting and inviscid compressible fluid, on the basis of generalized two classical theorems and with the aid of Gibbs thermodynamical identities. The two classical theorems are the Kelvin theorem about conservation of circulation and the Helmholtz theorem about freezing-in of vortex lines in a fluid with attendant conservation of vortex tube intensity. The variational formulation is based on Lagrange equations and a generalized Clebsch transformation. The author thanks Yu.I. Neymark for interest. References 9: 7 Russian, 2 Western (1 in Russian translation).

2415/9835
CSO: 1861/494

UDC 536.423:537.29

EFFECT OF ELECTRIC FIELDS ON KINETICS OF PHASE TRANSITIONS

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 50, No 5, May 86 (manuscript received 6 Mar 85) pp 729-735

[Article by L.A. Babenya, A.G. Goloveyko, V.I. Novikova, B.M. Pavlov, I.A. Satikov, N.F. Sharonov, and Z.M. Yudovin, Institute of Heat and Mass Transfer imeni A.V. Lykov, BSSR Academy of Sciences, and Belorussian Polytechnic Institute, Minsk]

[Abstract] An experimental study of evaporation was made involving polar and nonpolar liquids, for the purpose of determining the effect of a strong non-uniform electric field on that process under conditions precluding electric

discharge. The apparatus consisted of a vertical glass tube with an inside diameter of 1.6 or 2.5 mm and a coaxial needle-ring electrode pair, the needle held vertically along the tube axis above the meniscus but with the point close to it and the ring around the tube somewhat below the meniscus. The voltage between the two electrodes was varied over the 1-6 kV range so that at 5 kV the electric field intensity varied from 10^8 V/m near the needle to 10^3 V/m near the ring. Experiments were also performed on individual liquid droplets. An analysis of the data and theoretical calculations based on the meniscus geometry, kinetic theory, and electric-to-thermal energy conversion reveal that such an electric field has only a very small effect on evaporation of liquids such as water with dipole-molecules, lowering the evaporation rate somewhat, and has no effect at all on evaporation of nonpolar liquids such as CCl_4. Figures 2; references 17: 14 Russian, 3 Western (all in Russian translation).

2415/9835
CSO: 1861/493

UDC 536.423.1:536.483

FORCED FLOW OF VAPOR-LIQUID STREAM THROUGH HORIZONTAL PIPES WITH FILM BOILING

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 50, No 5, May 86 (manuscript received 18 Feb 85) pp 724-729

[Article by E.K. Kalinin, V.I. Panevin, and V.P. Firsov, Moscow Institute of Aviation imeni Sergo Ordzhonikidze]

[Abstract] Flow of a two-phase stream through horizontal pipes and attendant heat transfer during steady or nonsteady cooling are analyzed, specifically flow of liquid nitrogen and its vapor generated by film boiling. The analysis is based on experimental data as well as on a system of six equations describing the process: two equations of continuity and two equations of momentum, for the liquid and for the vapor, equation of heat balance, and equation of state for the vapor. The experiment was performed with pipes made of Cr18Ni10Ti steel. Small and thin pipes, with 19 mm and 35 mm inside diameters and 0.5 mm wall thickness, were cooled steadily. Large and thick pipes, with 70 mm inside diameter and 3.35 mm wall thickness, were cooled nonsteadily. The variables in this experiment were pressure (0.12-0.5 MPa), flow rate (40-350 $kg/m^2 \cdot s$), thermal flux density at heat-transferring lateral surface (10-82 kW/m^2), and temperature drop along pipe (0-2.5 K). Measurements were made by the "helium indicator" method. For visual examination of the flow pattern, it was photographed through an electrically-heated quartz tube immediately following the steel pipe. The experimental data fit the relation $N_{Nu} = 0.023 N_{Re}^{0.8} N_{Pr}^{0.4}$ for the upper part of such channels, taking into account friction at the pipe walls as well as between phases and capillarity effects. With the aid of these data it thus is possible now to calculate the flow characteristics of cryogenic fluids in horizontal channels, accurately within 15%, for design of the cooling

system. Figures 4; references 8: 4 Russian, 4 Western (1 in Russian translation).

2415/9835
CSO: 1861/493

UDC 532.529

NUMERICAL AND EXPERIMENTAL ANALYSIS OF NONISOTHERMAL TURBULENT JET WITH HEAVY SUSPENDED PARTICLES

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 50, No 5, May 86 (manuscript received 30 Apr 85) pp 735-742

[Article by L.B. Gavin, A.S. Mulgi, and V.V. Shor, Kaliningrad Engineering Institute of Fishing Industry and Management, and Institute of Thermophysics and Electrophysics, ESSR Academy of Sciences, Tallinn]

[Abstract] A mathematical model is constructed for analysis of a nonisothermal but isobaric axisymmetric turbulent two-phase jet discharging into a plenum, a jet of gas with suspended solid particles. The partial differential equations of this model in the approximation of boundary-layer theory take into account both velocity and temperature unbalance between the two phases as well as rotational motion of the particles. The correlations between fluctuations of gas parameters are expressed in the form of gradients. Dynamic interaction of the phase within the jet is described in terms of drag force and Magnus force. The temperature dependence of molecular viscosity of air is described by the Sutherland relation. To this are added partial differential equations representing the laws of momentum and energy conservation, also integral equations for the Euler fluctuations of velocities and temperature. An experiment for determination of empirical quantities was performed with an air jet carrying corundum micropowder, such a jet having been discharged from a compressor through a special helical nozzle for control of the micropowder rate from 0 to 0.5±2% kg/s into a 3 m long horizontal tube 16 cm in diameter and heated electrically by a controllable 13 kW power supply to temperatures up to 800 K. The numerical solution of the system of model equations for given initial and boundary conditions, based on conventional values of constants and the Prandtl number equal to 0.86, agree closely with the results of measurements. Figures 4; references 16: all Russian.

2415/9835
CSO: 1861/493

UDC 534.24

ACOUSTIC PROBING OF GAS BUBBLES IN MARINE MEDIUM

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 3, May-Jun 86
(manuscript received 22 May 85) pp 289-295

[Article by V.A. Akulichev, V.A. Bulanov, and S.A. Klenin, Pacific Institute of Oceanology, Far Eastern Science Center, USSR Academy of Sciences]

[Abstract] The feasibility of acoustically probing the sea or ocean water for inclusions, solid and gaseous, on a broader than merely local scale on the basis of backscattering has been established theoretically and confirmed experimentally. The method is based on the interrelation between the frequency spectrum of backscattering intensity and the size distribution of phase perturbing inhomogeneities. Experiments were performed with a parametric highly directive sound radiator tunable over the 4-40 kHz frequency range, a 150 kHz pumping oscillator with power amplifier, and a pair of hydrophones, also a synchro transmitter and a sweep generator feeding a multichannel magnetic recording instrument interfaced with a computer. The hydrophones, placed some distance apart within the range of the sound radiator, also fed signals to the magnetic recorder, through a band filter and amplifier each, for processing and analysis. Measurements made with probing acoustic pulses cover the frequency and the Q-factor of gas bubbles and solid particles as backscatters, depending on the radii of these inclusions and on the duration of acoustic pulses equal to or longer than the transient period of buildup of bacscaterer phase oscillations. These data allow separation of gas bubbles from solid particles in determination, on this basis, of their concentrations size by size. Figures 6; tables 1; references 15: 5 Russian, 10 Western (1 in Russian translation).

2415/9835
CSO: 1861/23

UDC 534.22:551.46

DEPENDENCE OF ACOUSTIC FIELD DISTRIBUTION IN DEEP SEA ON FORM OF VELOCITY PROFILE NEAR WATER SURFACE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 3, May-Jun 86
(manuscript received 26 Aug 85) pp 296-302

[Article by V.S. Buslayev and M.V. Perel, Department of Physics, Leningrad State University imeni A.A. Zhdanov]

[Abstract] The field of a monochromatic acoustic point source in a horizontally homogeneous layer of deep sea water is considered, of particular

concern being spikes of sound intensity within the far-field convergence zone. The dependence of their changing magnitude and location within this zone on the depth of source immersion and correspondingly on the vertical velocity profile across the subsurface layer is analyzed on the basis of the "four rays" formula for smoothing medium-scale field intensity fluctuations, assuming that both sound source and sound receiver are located sufficiently far below the surface with a large horizontal distance between them. This formula contains the normalized solution to the depth or "bathymetric" equation of an oceanic waveguide, which is modified here so as to make the formula applicable not only to velocity profiles satisfying the WKB approximation but also to other velocity profiles without reference to that approximation. Such a refinement has been validated by analysis of field data pertaining to the tropical region of the Atlantic Ocean. Calculations indicate that sound intensity spikes will appear within the convergence zone when the sound source is located within the thermal wedge, but not when it is located within the mixing layer. Figures 2; references 9: 6 Russian, 3 Western (1 in Russian translation).

2415/9835
CSO: 1861/23

UDC 551.463.26

ENERGY CHARACTERISTICS OF SOUND BACKSCATTERING BY ROUGH OCEAN SURFACE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 3, May-Jun 86 (manuscript received 6 Feb 85) pp 303-309

[Article by N.N. Galybin, Institute of Acoustics imeni N.N. Andreyev, USSR Academy of Sciences]

[Abstract] For the purpose of determining the energy characteristics of the acoustic field reradiated by a rough ocean surface and especially the backscattering coefficient from available experimental data, an adequate mathematical model is constructed which renders a reliable physical interpretation. A real ocean surface with a continuous spectrum of random ripples is represented as a superposition of two surfaces with large-scale and small-scale roughness respectively. This "two scales" model covers a wide range of sound wave grazing angles over a wide frequency range at wind velocities up to 11 m/s. The backscattering coefficient is calculated as the sum of two coefficients corresponding respective resonance components of the ocean surface ripple. Each is evaluated analytically and statistically on the basis of complete data on the space spectrum and the energy distribution of elementary plane surface waves, depending on the wave number as well as on the azimuth angle between direction of the wind and the direction of wave propagation. The model is accurate when properly matched to measurements with directional or nondirectional acoustic transceiver antennas respectively. The author thanks I.B. Andreyeva and participants in the seminar she conducted for fruitful discussions and valuable comments. Figures 2; references 11: 7 Russian, 4 Western.

2415/9835
CSO: 1861/23

UDC 534.231

FREQUENCY FILTRATION IN MODEL ACOUSTIC WAVEGUIDES

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 3, May-Jun 86
(manuscript received 25 Jun 84) pp 317-321

[Article by N.V. Gorskaya and G.K. Ivanova, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] Frequency filtration of an acoustic field established by a wide-band sound source in two models of an oceanic waveguide is analyzed, in a configuration where the sound intensity is not an oscillating function of the distance from the source but only of the source frequency. One model is a two-layer waveguide with soft transition from the low-velocity upper layer to the high-velocity lower layer. The other model is a waveguide with the low-velocity layer including the minimum-velocity axis sunken below another high-velocity layer and, as in the first model, a high-velocity layer underneath. Calculations based on theoretical expressions for the amplitudes of acoustic modes and the amplitude of sound pressure squared, all depending on the frequency, agree closely with the results of measurements and sound recording experiments with signals covering the 360-720 kHz frequency range and the 42-2.1 mm wavelength range. Figures 6; references 9: all Russian.

2415/9835
CSO: 1861/23

UDC 531.3

OPTIMAL CONTROL FUNCTION FOR STOPPING ROTATION

Moscow MEKHANIKA TVERDOGO TELA in Russian No 2, Feb 86
(manuscript received 17 Apr 85) pp 18-24

[Article by Yu.V. Golubev and V.N. Demidov, Moscow]

[Abstract] Norm-invariant systems are those in which the standard Euclidean norm is the first integral of the unperturbed equations of motion. A rigid body rotating about its center of mass is considered to be such a system. The stopping of system rotation is analyzed for two cases: 1) The optimal control that stops the rotation in the minimum time while satisfying an energy input constraint; 2) The determination of the optimal control that stops the system rotation in a fixed time with a minimal energy input. This mathematical analysis makes it possible to take into account the presence of a known analytical solution and the two-parameter family of first integrals of Euler's unperturbed dynamic equation. The purely theoretical analysis derives expressions for the control functions in the above two cases, but adduces neither design examples nor sample calculations. References 15: 12 Russian, 3 Western [1 in Russian translation].

8225/9835
CSO: 1861/376

UDC 539.3:534.1

NONSTEADY-STATE VIBRATIONS IN ACOUSTIC MEDIUM OF ELASTIC ELLIPTICAL SHELL SUBJECTED TO INSTANTANEOUSLY APPLIED UNIFORM PRESSURE

Moscow MEKHANIKA TVERDOGO TELA in Russian No 2, Feb 86
(manuscript received 15 Sep 85) pp 173-179

[Article by V.V. Karpenko, A.S. Pankratov and V.I. Saygina, Leningrad]

[Abstract] An external pressure is instantaneously applied to a thin, elastic, structurally orthotropic shell, the center surface of which forms an

elliptical cylinder. The nature of the load and the structural geometry make it possible to treat the motion of the shell as a planar shell using thin-shell theory. This paper analyzes the influence of the ratio of the minor to the major axes on the nature of the vibrations of such a shell. Cumbersome analytical expressions are derived and solved numerically in order to illustrate the normal deflection of the cylinder for minor to major axis ratios of between 0.5 and 1.0. The process of the deformation of circular and elliptical rings loaded by the same external pressure is shown to be qualitatively different and is depicted graphically. The influence of a frame-type reinforcement for an elliptical shell on the rate of change in the deformation for a minor to major axis ratio of 0.90 is also shown graphically. The influence of the stiffening frame on the overall stresses at the internal boundary of an elliptical ring due to compression and bending is also graphed. The equations in this paper can be extrapolated to an arbitrary load by means of a Duhamel integral. No information is provided on the computer procedures used for the numerical simulation. Figures 5; references 9: 7 Russian, 2 Western [1 in Russian translation].

8225/9835
CSO: 1861/376

NEED FOR COMPOSITES, NEW MATERIALS DISCUSSED

Moscow IZVESTIYA in Russian 1 Sep 86 p 2

[Article by Academicians N. Zhavoronkov and I. Fridlyander and Doctor of Technical Sciences R. Shalin, "Materials of the Future Needed Today"]

[Text] The effectiveness of any design (cars and trucks, aircraft, agricultural machinery, ocean and river vessels, etc.) greatly depends on the properties of the construction materials. Therefore designers demand increasingly strong and lightweight materials.

Today, the strength of high-quality steels has attained 200-250 kg/mm^2, the corresponding figures for aluminum alloys being 50-60 kg/mm^2. However, as high as these properties are, they are still very far from the theoretical strength of crystalline materials.

What is the reason for this? Most of the difference between the theoretical and practical strength is due to microstructure defects. These are not defects such as pipe cavities in castings or cracks in rolled products, but crystal lattice defects. These defects are called dislocations. Their numbers are enormous--billions per square centimeter of a crystal surface. It is necessary to eliminate the dislocations in order to approach the theoretical strength. And this can be achieved only when the cross section area of the body is very small. This is why only thin fibers can have a strength that approaches the theoretical strength.

Today's technology has been able to create high-strength fibers with a relatively low density.

For example, there has been a rapid growth in research in the area of silicon carbide fibers during the recent years. Their mass production has been developed in Japan. These fibers (their trade name is Nicalon) have a low density and high strength properties. The properties of Nicalon are practically constant at temperatures between absolute zero and +500 degrees.

The range of laboratory studies and industrial production of the fibers has been growing rapidly. In the USA, Japan, and Western Europe, in addition to these fibers, high-strength organic fibers as well as short silicon carbide and aluminum oxide fibers ("whiskers") are already in widespread use.

Startling increases in the properties of the fibers have been achieved. For example, carbon fibers produced experimentally are 2-3 times stronger than the best steels and 5 times lighter.

In order to convert the fibers into structural semifinished products (sheets, plates, shapes) they are bonded with synthetic resins, aluminum and other alloys, and ceramic materials. The result is composite materials that possess unique sets of properties.

It should be stressed that the use of composite materials results in fundamental changes in the technology of production of articles. In aircraft production, plates, structural shapes, and forgings are milled, turned, and bored. In a large aircraft thereaare as many as 1-2 million rivets and bolts. Machine tools are not needed in the case of composite materials. Braided straps [zhgut], strips, and fabrics with optimal arrangement of fibers for a given unit are produced on looms with the aid of computers. Then they are converted to parts or semifinished products by means of a binder such as a polymer binder. Subsequently, the parts are joined, preferably by means of adhesives. The production is highly automated and results in little scrap.

Thus, composite materials transform the entire machine production, making it practically fully automatic and almost scrapless.

There is no doubt that composite materials really give rise to the present-day technological revolution in modern structures and articles. In terms of strength and weight, they are several times better than the best traditional materials. The importance of composite materials is clear from the following example. An airplane has been built in the USA in which the wings show a forward rather than backward sweep. This design offers great aerodynamic advantages, but it requires very rigid wings. Only composite materials can provide such rigidity. In addition, they possess exceptionally high fatigue strength. Thus, the changeover to composite materials increases by several times the life of the blades of the main helicopter rotor.

In the giant Soviet airplane Ruslan, many load-bearing elements and units, including the largest panels in the world, are made from fiberglass and carbon composites. This required the development and use of a fundamentally new technology and made it possible to reduce the weight of the units by 30 percent.

In shipbuilding, composite materials, particularly fiberglass, are widely used in new types of vessels (hydrofoils and hovercraft) and also in sport and pleasure boats.

Our domestic industry has made serious achievements in the area of composite materials. However, the pace of research and production increase should be increased significantly. It is also necessary to change the attitudes of scientific workers, designers, industry workers, and management with regard to composite materials. They should be the main lever of the technical progress today and not in some distant future.

Documents of the 27th Congress point out that it is imperative to master the production of new forms of high-strength fibers and whiskers. The integrated program for the scientific and technical progress of the member countries of the COMECON provides for the development of industrial production of a wide assortment of new high-strength materials. It is necessary to begin practical realization of these decisions without delay. The ministries of the chemical industry and nonferrous metallurgy and other allied ministries should ensure their absolute fulfillment.

12973/9835
CSO: 1861/13

ARTICLE DESCRIBES NEW EMERY CLOTH

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 14 Oct 86 p 2

[Article by A. Apostolyuk: "The Secret of a Durable Abrasive."]

[Text] Everyone knows how quickly emery cloth wears out. But a new emery cloth developed at the Ukrainian Printing Institute lasts longer than the average type by a factor of ten or more.

The project leader, Docent V. Morozov, says: "The secret lies in the fact that we have learned to make abrasive belts with preprogrammed grain distribution. Rather than applying the abrasive material as a solid mass, we apply it in bands alternating with blank spaces. During use, abrasive dust gathers in these blank grooves, thereby improving heat removal from the working area and increasing belt durability."

The Lvov scientists have had long-standing ties with the Chelyabinsk Abrasive Materials Factory, and it is this factory which has been the first in the country to implement this new technology that is expected to save more than 1.5 million rubles this year.

During their work on this project the laboratory collective also developed a method for separating abrasive materials electrostatically. This method has already moved from the laboratory to industry: The Zaporozhye Abrasive Factory liked the idea and is now installing a special production line in the city of Borislav at an affiliated branch of the Lvov "Diamond-Tooling" Union.

12997
CSO: 1861/69

UDC 621.791.92

HARDENING OF PUNCHES BY LASER TREATMENT WITH CYANIDING

Kiev TEKHNOLOGIYA I ORGANIZATSIYA PROIZVODSTVA in Russian No 3, Mar 86 pp 47-48

[Article by T.V. Shemeneva, candidate of technical sciences, G.B. Rozenboym, candidate of technical sciences, T.A. Popova, candidate of technical sciences, and N.V. Korchevskiy, engineer]

[Abstract] One technological application of laser treatment is hardening such tools as steel punches and dies for operation at high temperatures. A laser beam can harden not more than a 30 μm thick surface layer of steel, however, and the feasibility of improving its effectiveness by simultaneous cyaniding was studied in an experiment with U8A and U10A shock-resisting tool steels and CrWMn, Cr12Mo and 40Cr alloy steels. Specimens of these steels were conventionally heat treated, whereupon their surfaces were coated with a 0.3-0.5 mm thick layer of paste containing $K_4Fe(CN)_6$ with 25-30 wt.% BF6 adhesive diluted in 20-25 wt.% acetone. The results of subsequent laser treatment revealed that much more radiation energy had been absorbed. The process thus becomes more energy efficient, 12-16 J of laser energy with the optimum amount of paste being sufficient to harden a 105 μm thick surface layer of 40Cr steel to H_M^{50} 900 or an 80 μm thick surface layer of Cr12Mo steel to H_M^{50} 1425. More than optimum doses of paste or radiation yield diminishing returns, which is attributable to decomposition of $K_4Fe(CN)_6$. Metallographic and microstructural examination revealed intense diffusion of C and N_2 into the surface layer of steel with attendant formation of carbonitride phases, as confirmed by phase analysis in a URS-50IM x-ray diffractometer. Laser treatment alone, without thermochemical treatment, was found not to produce nitride phases in these steels. Wear measurements have revealed that the wear resistance is highest after heat treatment + laser treatment with cyaniding, lower after heat treatment + laser treatment alone, and lowest after heat treatment alone. Figures 2; tables 1.

2415/9835
CSO: 1861/46

UDC 621.94.1

OUTLOOK FOR INDUSTRIAL USE OF CUTTERS WITH BLADES MADE OF TUNGSTENLESS HARD ALLOY CoTiNi-16 ON CALCIUM-REDUCED STEEL IN LATHE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 8, Aug 86 (manuscript received 28 Mar 86) pp 148-152

[Article by V.B. Yesov, graduate student, and V.P. Pokrovskiy, candidate of technical sciences, docent]

[Abstract] Owing to the scarcity of tungsten, tungstenless hard alloys are considered for cutting tools. It is necessary, however, to reduce the tendency of tungstenless alloys to pitting and chipping at the cutter edge. One such tungstenless alloy, CoTiNi-16, is evaluated relatively to the Ti15Co6 alloy containing tungsten and now used for machining calcium-reduced steel. The evaluation is based on available data on cutting force, heating, wear, and life of cutters in lathe operation on ATs45 calcium-reduced steel and, for comparison, on plain 45 carbon steel at a feed rate of 0.3 mm/rev and at speeds of 1.5-6.0 m/s without lubricant-coolant fluid. An analysis of these data has yielded a semiempirical exponential-power relation between tool life and cutting speed which indicates that, with necessary adjustments of the process parameters for ATs45 steel and 45 carbon steel respectively, is quite feasible. Figures 2; tables 1; references 3: all Russian.

2415/9835
CSO: 1861/29

UDC 539.23

LASER-INDUCED SYNTHESIS OF NITRIDE PHASES ON SURFACE OF TITANIUM OR TITANIUM ALLOYS

Minsk VESTSI AKADEMII NAVUK BSSR: SERYYA FIZIKA-TEKHNICHNYKH NAVUK in Russian No 3, Jul-Sep 86 (manuscript received 26 Sep 85) pp 30-33

[Article by S.A. Astapchik and T.N. Khatko, Institute of Engineering Physics, BSSR Academy of Sciences]

[Abstract] The feasibility of synthesizing nitride phases on the surface of refractory metals or alloys in a liquid-nitrogen bath by means of laser radiation below the optical breakdown threshold has been demonstrated experimentally, with a neodymium laser. The laser emitted millisecond pulses in a beam with a power density sufficient to melt a 300 μm deep surface layer of titanium or titanium alloy. The liquid nitrogen was found not to attenuate the laser beam, being evidently transparent to infrared radiation. The target materials in this experiment were iodized titanium and several Ti-W alloys: α-WTi1-0, (α+β)-WTi6, (α+β)-WTi3-1 with high β-stabilizers content,

β-WTi-15. Phase analysis of the surface layer after laser treatment in a DRON-2.0 x-ray diffractometer with a CoK_{α}-radiation source revealed lines from (111), (200), (220), (222), (311) planes in TiN with a b.c.c. crystal lattice in each case, the concentration of this dendritic phase decreasing depthwise but the depth of its penetration increasing with repeated laser treatment cycles. A laser beam with a power density lower than necessary for melting the surface layer produced a Ti_2N phase. No oxides were produced in a liquid-nitrogen bath, but abundant TiO_2 and α-TiO_2 films were produced in air. Nitrides were also synthesized under analogous conditions on the surface of other refractory metals: V,Cr,Nb,Mo,Ta,W. Figures 2; references 6: 5 Russian, 1 Western.

2415/9835
CSO: 1861/28

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